LAWRENCE BERKELEY NATIONAL LABORATORY (LBNL)
SUMMARY OF SEMI-ANNUAL ACTIVITIES
FIRST AND SECOND QUARTERS FY04
(October 1, 2003 to March 31, 2004)

GROUNDWATER MONITORING

Summary of Groundwater Sampling

First quarter fiscal year (FY) 2004 groundwater sampling started on October 30, 2003 and was completed on December 16, 2003. Second quarter FY 2004 groundwater sampling started on January 21, 2004 and was completed on March 30, 2004. A preliminary review of the data indicates that first and second quarter FY 2004 results are consistent with those from previous quarters. The number of groundwater samples submitted for each type of analysis during each quarter is shown on the following tables:

Number of Groundwater Samples Collected During the First Quarter of FY 2004

	VOCs	TPH-K	PCBs	Metals	Anions	Tritium	Total Samples
Monitoring Wells Primary	58	1	2	1	1	35	98
Duplicates	4					3	7
Trip Blanks	4						4
Rinse Blanks	7					2	9
Slope Stability Wells	2						2
Temporary Groundwater Sampling Points	34			1	1	11	47

Number of Groundwater Samples Collected During the Second Quarter of FY 2004

	VOCs	TPH-D	TPH-G	TPH-K	PCBs	Metals	Anions	Tritium	Total Samples
Monitoring Wells Primary	111	3	3	2	2	1	1	61	184
Duplicates	4							3	7
Splits									
Trip Blanks	4								4
Rinse Blanks	10			1				4	15
Slope Stability Wells								4	4
Temporary Groundwater Sampling Points	62				5	1	1	21	90

VOCs= Volatile Organic Compounds
TPH-D=Total Petroleum Hydrocarbons in the diesel range
TPH-G=Total Petroleum Hydrocarbons in the gasoline range
TPH-K=Total Petroleum Hydrocarbons in the kerosene range
PCBs=Polychlorinated Biphenyls

HYDROGEOLOGICAL INVESTIGATIONS

Well Yield

Groundwater monitoring wells and temporary groundwater sampling points were tested for sustained yield to provide information for the Corrective Measures Study (CMS) Report. Based on criteria in State Water Resources Control Board (SWRCB) Resolution 88-63, the groundwater is not considered a potential drinking water source where wells cannot produce at least 200 gallons per day (gpd).

Water Level Measurements

Depth-to-water was measured monthly in all groundwater monitoring wells. The data are used to plot hydrographs for various monitoring wells.

Building 71B Lobe of the Building 71 Solvent Plume

Information collected during the chemical oxidation pilot test at Building 71B indicated that the axis of the Building 71B lobe of the Building 71 Solvent Plume was oriented toward the southwest near the Building 71B source area, and not westward toward MW71B-98-13 and the former North Fork Strawberry Creek drainage. To confirm this hypothesis, temporary groundwater sampling point SB71-04-1 was installed southwest of Building 71B on March 31, 2004. The location of SB71B-04-1 is shown on Figure 1. Construction details for SB71B-04-1 are provided in the following table:

Construction Details for Temporary Groundwater Sampling Point SB71B-04-1

Boring Depth (feet bgs)	Boring Diameter (inches)	Casing Diameter (inches)	Screen Interval (feet bgs)	Slot Size (inches)	Geologic Unit in Sandpack Interval	Sandpack Interval (feet bgs)	Bentonite Pellets (feet bgs)	Grout (feet bgs)
33	11	4	23 to 33	0.010	Orinda Formation	21 to 33	17 to 21	0 to 17

bgs: below ground surface.

Groundwater samples were collected from the new sampling point at the beginning of April 2004. Results are not yet available.

SOURCE INVESTIGATIONS

Building 51A Contaminated Subdrains

Investigation of the Building 51A subdrain continued. On October 1, 2003, a video camera was used to survey the condition of the subdrain outside the building. A 6-inch rain leader from the roof was discovered to be connected to the subdrain. The rain leader was rerouted to the storm

drain. Six temporary groundwater sampling points (SB51-03-1 to SB51-03-6) and six soil gas sampling points (SG51-03-1 to SG51-03-6) were installed adjacent to the south side of Building 51 to help locate the source of volatile organic compounds (VOCs) detected in water in the drain lines. The locations of the temporary groundwater sampling points and soil gas sampling points are shown on Figure 2. Sampling point construction details are listed in the table below:

Construction Details for Temporary Groundwater Sampling Points and Soil Gas Sampling Points at Building 51A Subdrain

	Boring Depth (feet bgs)	Boring Diameter (inches)	Casing Diameter (inches)	Screen Interval (feet bgs)	Slot Size (inches)	Bentonite (feet bgs)
Groundwater Sampling Point	19.5	2.5	¾	14.5 to 19.5	0.010	0 to 1
Soil Gas Sampling Point	9.5	2.5	¾	4.5 to 9.5	0.020	0 to 1

bgs: below ground surface.

Flame ionization detector (FID) monitoring was conducted as the borings for the temporary groundwater sampling points were advanced. The FID was lowered approximately 2 feet into each of the borings after each four foot hole advance. The FID readings generally increased to a maximum when the borings were 16-feet deep, at approximately the depth of the subdrain. Groundwater samples were collected from the temporary groundwater sampling points and analyzed for VOCs by EPA Method 8260. Tetrachloroethene (PCE), trichloroethene (TCE), and cis-1,2-dichloroethene (DCE) were detected. Results are provided in the following table:

Concentrations of VOCs Detected (µg/L) in Groundwater Samples Collected from SB51-03-1 to SB51-03-6

	SB51-03-1			SB51-03-2			SB51-03-3		
	Oct-03	Nov-03	Jan-04	Oct-03	Nov-03	Jan-04	Oct-03	Nov-03	Jan-04
PCE	ND	ND	ND	1.3	16	31	3.5	8.1	7.0
TCE	1.0	1.4	4.6	1.5	10	25	1.5	2.0	2.1
cis-1,2-DCE	ND	1.1	1.1	1.3	4.0	24	ND	ND	ND
	SB51-03-4			**SB51-03-5**			**SB51-03-6**		
	Oct-03	Nov-03	Jan-04	Oct-03	Nov-03	Jan-04	Oct-03	Nov-03	Jan-04
PCE	ND	ND	ND	ND	1.9	1.3	ND	2.1	1.1
TCE	ND	ND	ND	ND	ND	ND	ND	ND	ND
cis-1,2-DCE	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND: not detected.

On March 5, 2004, temporary groundwater sampling point SB51-04-1 was installed adjacent to SB51-03-2, where the maximum concentrations of VOCs were detected in the groundwater. The location of SB51-04-1 is shown on Figure 2. Construction details for SB51-04-1 are provided in the following table:

Construction Details for Temporary Groundwater Sampling Point SB51-04-1

Boring Depth (feet bgs)	Boring Diameter (inches)	Casing Diameter (inches)	Screen Interval (feet bgs)	Slot Size (inches)	Geologic Unit in Sandpack Interval	Sandpack Interval (feet bgs)	Bentonite Pellets (feet bgs)	Grout (feet bgs)
20	8	2	9 to 19	0.010	Fill	8 to 20	5 to 8	0 to 5

bgs: below ground surface.

Soil samples were collected from the boring for SB51-04-1 at four depths between 10 and 19.5 feet below ground surface (bgs) and analyzed for VOCs by EPA Method 8260. The only analyte detected was PCE (0.12 mg/kg) at a depth of 15.3 feet.

During the fourth quarter of FY 2003, an investigation was started to locate the source of the contaminated water in the subdrains. The area inside the building where the tile drains connect to the cast iron pipe upflow from the catch basin was excavated and four soil samples were collected from the base of the excavation at depths between 2 and 3 feet bgs. Low concentrations of VOCs, TCE (0.018 mg/kg) and cis-1,2-DCE (0.0072 mg/kg) were detected in one of the samples. In addition, a composite sample collected from the excavated soil had 21 mg/kg of mercury. In March 2004, the excavation was deepened to 5 feet and additional samples were collected at depths of 5 and 7 feet at one location. Samples were analyzed for VOCs by EPA Method 8260. No VOCs were detected. The location of the excavation and sampling locations are shown on Figure 3.

Slope East of Building 64

According to verbal communications from laboratory employees, solvents may have been spilled on the slope behind the retaining wall east of Building 64. In order to evaluate whether soil and/or groundwater in this area had been impacted by VOCs, two temporary groundwater sampling points (SB64-03-12 and SB64-03-13) and eleven soil borings (SB64-04-1 through SB64-04-11) were installed east of the building. The temporary groundwater sampling points were installed on December 12, 2003. The borings were drilled on the slope east of the retaining wall in January and March 2004. The locations of the temporary groundwater sampling points and soil borings are shown on Figure 4. Construction details for the temporary groundwater sampling points are provided in the following table:

Construction Details for Temporary Groundwater Sampling Points SB64-04-12 and SB64-04-13

Temporary Groundwater sampling Point	Boring Depth (ft bgs)	Boring Diameter (inches)	Casing Diameter (inches)	Screen Interval (ft bgs)	Slot Size (inches)	Geologic Unit in Sandpack Interval	Sandpack Interval (ft bgs)	Bentonite Chips (ft bgs)	Grout (ft bgs)
SB64-03-12	15	8	2	5-15	0.010	Orinda Formation	4 to 15	1 to 4	0.5 to 1
SB64-03-13	25	8	2	15-25	0.010	Orinda Formation	14 to 25	12 to 14	1 to 12

bgs: below ground surface

Groundwater samples were collected from both temporary groundwater sampling points and analyzed for VOCs by EPA method 8260. The primary contaminants detected were 1,1-dichloroethane (DCA) and TCE. Concentrations of VOCs detected are listed in the following table:

Concentrations of VOCs Detected (µg/L) in Groundwater Samples Collected from SB64-03-12 and SB64-03-13.

	SB64-03-12		SB64-03-13	
	Jan-04	Feb-04	Jan-04	Feb-04
PCE	3.2	ND	ND	ND
TCE	3.7	4.2	10.4	17
1,1-DCA	3.8	3.2	20	28
1,1-DCE	ND	ND	6.2	11

ND: not detected

Soil samples were collected from the eleven soil borings at approximately 3, 6, and 9 feet bgs and analyzed for VOCs by EPA Method 8260. Detected contaminants consisted primarily of xylenes (0.57 mg/kg maximum) and smaller concentrations of TCE, PCE, ethylbenzene, and 1,2,4-trimethylbenzene, as shown in the following table. The low concentrations of VOCs detected in soil indicate that soil in the sampled area is unlikely to constitute the source of the groundwater contamination.

Concentrations of VOCs Detected (mg/kg) in Soil Samples Collected from SB64-04-1 through SB64-04-11.

Boring Number	Depth (feet bgs)	xylenes	TCE	Other VOCs
SB64-04-1	3	0.066	ND	ethylbenzene = 0.0073
	6	0.012	ND	
	8.9	ND	ND	
SB64-04-2	3	ND	ND	
	5.9	0.034	ND	
	8.9	ND	0.0061	PCE = 0.0077
	12.5	0.012	ND	1,2,4-trimethylbenzene = 0.0058
	15.2	ND	0.0079	
SB64-04-3	3, 5.8, and 8.6	ND	ND	
SB64-04-4	3, 6, and 8.8	ND	ND	
SB64-04-5	3.2	0.028	ND	
	6.5 and 8.8	ND	ND	
SB64-04-6	2.8, 6.2, and 9.2	ND	ND	
SB64-04-7	3	0.57	ND	ethylbenzene = 0.04
	5.8	0.01	ND	
	8.9	ND	0.011	
SB64-04-8	3	0.031	ND	
	6 and 9.5	ND	ND	
SB64-04-9	3.1 and 6	ND	ND	
	9.3	ND	0.0059	
SB64-04-10	3.1, 6.3, and 9.2	ND	ND	
SB64-04-11	3, 5.9, and 9.1	ND	ND	

ND: not detected
bgs: below ground surface

INTERIM CORRECTIVE MEASURES (ICMs)

Old Town Solvent Plume (Building 7 lobe)

Extraction and treatment of groundwater continued at the following locations:

- Building 7 Groundwater Collection Trench
- Building 58 West Groundwater Collection Trench
- Building 58 East Groundwater Collection Trench.

Dual-phase (groundwater and soil vapor) extraction continued at the Building 53/58 Slope Groundwater Collection Trench.

Old Town Solvent Plume (Building 25A Lobe)

Extraction and treatment of groundwater from the Building 25A Groundwater Collection Trench (west of Building 25A) and groundwater monitoring well MW25A-98-3 (north of Building 25A) continued. The treated water is recirculated into a shallow gravel infiltration bed

located upgradient of the trench between Buildings 25A and 44A, to help flush contaminants from the soil.

Building 7E Former Underground Storage Tank (UST) (AOC 2-1)

Operation of the Building 6 dual-phase (groundwater and soil vapor) extraction and treatment systems continued until March 1, 2004.

Building 51/64 Solvent Plume

Operation of the groundwater extraction and treatment system in the Building 51/64 solvent plume source area excavation continued.

Building 51 Motor Generator Room Discharge Sump Treatment System

Extraction and treatment of water from the Building 51 drainage system continued.

Building 51L Area

Operation of the groundwater extraction and treatment system for the Building 51L solvent plume continued.

Building 51A Catch Basin (Building 51 Subdrains)

Extraction and treatment of water from the concrete sump installed immediately upgradient of the Building 51A storm drain catch-basin continued. The sump collects contaminated water from the two drain lines that formerly flowed into the catch basin.

Building 37 Solvent Plume

Extraction and treatment of groundwater from monitoring wells MWP-7 and MW37-92-6 was discontinued in June 2001. Concentrations of VOCs detected in both wells have remained below Maximum Contaminant Levels (MCLs) for drinking water through the current reporting period.

Building 71 Solvent Plume

Operation of the Building 51 Fire Trail Treatment System continued. The system treats effluent from hydraugers east of Building 51 that contain detectable concentrations of VOCs.

Building 71B Lobe of the Building 71 Solvent Plume Source Area ICM

In November 2003, LBNL submitted a workplan to the Department of Toxic Substances Control (DTSC) for the excavation of additional contaminated soil in the source area of the Building 71B lobe of the Building 71 Groundwater Solvent Plume. The first part of the ICM consisted of removing small sections of concrete from the deck slab on the south side of the

building to allow the collection of 20 soil samples from 7 borings (SB71BAdExc-03-1 through -7). In December 2003, samples were collected at approximately 3, 6, and 9 feet beneath the concrete and analyzed for VOCs. PCE (4.5 mg/kg maximum), TCE (0.96 mg/kg maximum), cis-1,2-DCE (0.36 mg/kg maximum), trans-1,2-DCE (0.11 mg/kg maximum), and methylene chloride (0.24 mg/kg maximum) were detected. PCE was detected in all the samples except two. The highest concentrations were generally detected in the samples collected at a depth of approximately 3 feet. The locations of the borings and concentrations of PCE detected are shown on Figure 5.

A large section of the concrete deck was then removed to allow the excavation of approximately 60 cubic yards of contaminated soil to a maximum depth of 8 feet. The extent of excavation was constrained due to limitations imposed to maintain the stability of the building foundation. Eleven confirmatory soil samples were collected from the walls (samples SS71BAdExc-03-W1 through -W8) and floor (samples SS71BAdExc-03-F1 through -F3) at the edges of the excavation. PCE (47 mg/kg maximum), TCE (0.14 mg/kg maximum), and cis-1,2-DCE (0.074 mg/kg maximum) were detected. The highest concentrations were detected on the southern ends of the east and west walls of the excavation. In addition, a sample (SS71BAdExc-03-F4) collected at a depth of 6 feet from the floor before the excavation was completed contained PCE (64 mg/kg maximum), TCE (23 mg/kg maximum), cis-1,2-DCE (3.7 mg/kg maximum), trans-1,2-DCE (0.012 mg/kg), and vinyl chloride (0.035 mg/kg). The locations of the samples and concentrations of PCE detected are shown on Figure 5. The excavation was backfilled with low strength concrete and the concrete slab repaired.

In February 2004, 26 samples were collected from 10 additional borings (SS71BAdExc-04-1 through -10) to further delineate the extent of the contamination. Nine of the borings were located approximately 3 to 8 feet from the excavation walls to determine the lateral extent of contamination and the tenth boring (SS71BAdExc-04-10) was located in the center of the excavated area to sample beneath the excavation floor near sample location SS71BAdExc-03-F4. PCE (2.3 mg/kg maximum), TCE (0.24 mg/kg maximum), and cis-1,2-DCE (0.45 mg/kg maximum), were detected. The maximum concentration of PCE was detected in boring SS71BAdExc-04-7, to the west of the excavation area. The maximum concentrations of cis-1,2-DCE and TCE were detected in the samples collected beneath the excavation floor (SS71BAdExc-04-10). In addition, ethylbenzene and xylenes were detected in samples collected from boring SS71BAdExc-04-2. The locations of the samples and concentrations of PCE detected are shown on Figure 5.

Building 88 Hydraulic Gate Unit

The Building 88 Hydraulic Gate Unit (Area of Concern 6-3) is included in the Corrective Measures Study (CMS) because of the potential risk from polychlorinated biphenyls (PCBs) beneath the concrete floor slab of the hydraulic gate pump room. PCB-contaminated soil beneath the pump room floor was excavated as an ICM in 1995; however, the cleanup could not be completed to the required extent because the Building 88 cyclotron is an active facility. The facility was expected to close in 2003, however, it has received additional funding for non-classified work from the Department of Defense. The facility will be temporarily shut down for two week periods in both May and July 2004. At the March Remedial Project Managers (RPM) meeting, the DTSC agreed that LBNL could implement an ICM during the shut down periods to excavate additional PCB-contaminated soil. To further delineate the lateral extent of contamination

in preparation for the ICM, soil samples were collected in March 2004 from two shallow borings (SB88-04-1 and SB88-04-2) located outside the pump room. Sampling locations are shown on Figure 6. Samples were collected at 0.7, 1.5, 2.5, and 3.3 feet bgs in SB88-04-1, and 0.7 feet and 1.4 feet bgs in SB88-04-2. No PCBs were detected (<0.01 mg/kg), indicating that the contamination did not extend outside the room toward the south.

PILOT TESTS

In-Situ Chemical Oxidation (ISCO) Pilot Test at Building 71B Solvent Plume Source Area

In September 2003, in preparation for the second phase of the *in-situ* chemical oxidation pilot test at Building 71B, six new injection points (SB71B-03-R10 through SB71B-03-R15) were installed on the south side of Building 71B. Two of the new injection points were located on the concrete deck. The locations of the injection points are shown on Figure 7. The injection points were designed to inject the chemical oxidant (hydrogen peroxide and citric acid) at three discrete depth intervals. From October 15 to October 17, 2003, hydrogen peroxide and citric acid were injected into the bottom two intervals; however, injection was not conducted in the shallowest interval due to saturated soil conditions. The average quantities injected into the deep interval of each injection point were 5.3 kg of citric acid and 12.3 kg of hydrogen peroxide. The average quantities injected into each middle interval were 2.4 kg of citric acid and 4.2 kg of hydrogen peroxide.

The injection intervals are listed in the following table.

In-Situ Chemical Oxidation Injection Points and Injection Intervals at Building 71B

Injection Point	Base of Concrete (feet bgs)	Top of Orinda Formation (feet bgs)	Bottom of Hole (feet bgs)	Chemical Oxidation Injection Intervals	
				Deep Interval (feet bgs)	Middle interval (feet bgs)
SB71B-03-R10	1.5	9.5	27	22-27	not injected
SB71B-03-R11	1.5	17	27	22-27	11-19
SB71B-03-R12	2.5	5	25	20-25	14-19
SB71B-03-R13	8	9	25	20-25	13-18
SB71B-03-R14	4	13	25	20-25	12-17
SB71B-03-R15	2	16	25	20-25	12-17

bgs: below ground surface

Post-injection groundwater samples were collected from monitoring well MW71B-99-3R and temporary groundwater sampling points SB71B-03-1 and SB71B-03-2 and analyzed for VOCs to monitor the performance of the test. Concentration trends for these wells are shown on Figure 8. Various changes were observed in the concentrations of VOCs in the three wells, with the only consistent change observed an increasing trend in the concentration of vinyl chloride in MW71B-99-3R for two months after injection, with decreases in the concentrations of PCE and

cis-1,2-DCE in the well over the same period. These relatively long-term changes cannot be attributed to chemical oxidation of the chlorinated solvents, which is a relatively rapid process; however, the injection of citric acid may have enhanced reductive dechlorination of the chlorinated solvents. Following the heavy December rainfall and subsequent rise in the water table, concentrations of PCE, TCE, cis-1,2-DCE, and vinyl chloride generally increased in the three wells monitoring the test. The increase is interpreted to have resulted from desorption of contaminants from soil upgradient from the pilot test area as the water table rose.

Hydrogen Release Compound (HRC®) Pilot Test at Building 71B Lobe of the Building 71B Solvent Plume Core Area

On September 26, 2003, approximately 300 pounds of Hydrogen Release Compound (HRC®) was injected into four geoprobe borings installed approximately 4 feet upgradient from groundwater monitoring well MW71B-98-13. The location and layout of the pilot test are shown on Figure 9. HRC® is a commercially available product that, when hydrated, releases lactic acid into the groundwater. The lactic acid is biotransformed and in the process releases hydrogen. Native bacteria can then use the released hydrogen as an electron donor, thus enhancing the reductive dechlorination process that can degrade chlorinated hydrocarbons in groundwater.

The geoprobe rods were advanced to a depth of 30 feet bgs. The HRC® injection process was then implemented by pulling back the rods in 1-foot steps and injecting approximately 4 to 5 pounds of HRC® per linear foot of boring. The target depth interval for injection was from approximately 12 to 30 feet bgs, the saturated interval of artificial fill containing VOC-contaminated groundwater. Groundwater samples were collected prior to injection from monitoring well MW71B-98-13. The samples were analyzed for VOCs and a number of parameters that are indicators for natural degradation processes, to establish baseline conditions for the test. Field measurements of dissolved oxygen content, electrical conductance, pH, and temperature were also recorded both prior to injection and daily thereafter for the first week. The pH dropped from the pre-injection level of 6.5 to 2.6 immediately following injection, and then stabilized at about 5 pH units. The electrical conductance of the groundwater also increased after HRC® injection. The decrease in pH and increase in electrical conductance is interpreted to indicate that the HRC® hydrated in the groundwater producing lactic acid needed for biological degradation of the TCE.

The variations in concentrations of VOCs detected in groundwater samples collected from groundwater monitoring well MW71B-98-13 are shown on Figure 10. Concentrations of PCE and TCE decreased from approximately 100 µg/L to approximately 5 µg/L (below MCLs) after HRC® injection, and have remained at those low levels for six months. Variations in concentrations of cis-1,2-DCE and vinyl chloride were similar, first increasing immediately following HRC® injection, then decreasing near the beginning of November 2003, and increasing again in January 2004 to concentrations similar to those detected prior to the test. The results indicate that biodegradation is occurring and the pilot test has been effective.

A potential concern with the use of HRC® is that concentrations of metals in the groundwater increased, apparently as the result of the lowered pH. Concentrations of barium and nickel increased to levels above the MCLs. The concentration of iron increased from 740 µg/L to 100,000 µg/L.

In-Situ Chemical Oxidation (ISCO) Pilot Test at Building 51L

During the fourth quarter of FY03, twelve chemical oxidation injection wells (IW51L-03-1 through IW51L-03-12) were drilled on the west side of Building 51L, including four angled injection wells (approximately 30 degrees from vertical) beneath the western edge of Building 51L. The injection wells were drilled at approximately 5-foot intervals in a hexagonal pattern to depths from 18 to 23 feet bgs, except for the four angled borings under the building which were drilled to a length of 24 feet (corresponding to a vertical depth of 21 feet bgs). The locations of the injection points are shown on Figure 11.

The test was designed to treat the engineered fill from a depth of approximately 5 feet bgs to the base of the fill at approximately 23 feet bgs, by injecting reagents into two discrete, approximately 7-foot thick injection intervals in each well. The shallow intervals were located between approximately 5 to 13 feet bgs and the deeper intervals were located between approximately 13 to 23 feet bgs. Each boring was drilled into the colluvium beneath the engineered fill, to ensure that the base of the fill section was treated.

On September 27 2003, injection of chemicals was started; however, the packers would not hold pressure without continual flow, indicating a leak somewhere in the packer system. Chemical oxidants were injected into only two of the points, IW51L-03-10 and IW51L-03-2, which allowed injection at a pressure of approximately 10 psi. The test was then halted pending modifications to the packer system.

From December 11 to December 13 2003, after packer system modifications were completed, citric acid and hydrogen peroxide were injected into both the shallow and deep intervals at all 12 injection points (except for two intervals). Approximately 430 gallons of reagent, consisting of 95 gallons of 10% citric acid, 75 gallons of 12.5% hydrogen peroxide solution, and 260 gallons of 17.5% hydrogen peroxide solution were injected in the deep interval. Approximately 210 gallons of reagent, consisting of 30 gallons of 10% citric acid and 180 gallons of 17.5% hydrogen peroxide solution were injected in the shallow interval. The injection points and injection intervals are listed in the following table.

***In-Situ* Chemical Oxidation Injection Points and Injection Intervals at Building 71B**

Injection Point	Fill/ Colluvium contact (feet bgs)	Colluvium/ Bedrock contact (feet bgs	Bottom of Hole (feet bgs)	Chemical Oxidation Injection Intervals	
				Deep Interval (feet bgs)	Shallow Interval (feet bgs)
IW51L-03-1	24	38	21	14-21	5-11
IW51L-03-2	23	34	21	14-21	5-11
IW51L-03-3	20.5	29.5	21	14-21	6-12
IW51L-03-4	18	24.5	21	14-21	6-12
IW51L-03-5	22.5	27	23	16.5-23	6-13
IW51L-03-6	21.5	26	23	16.5-23	6-13
IW51L-03-7	20	25	20	not injected	6-20
IW51L-03-8	18	24	20	12.5-20	7-20
IW51L-03-9	16.5	23	18	11-18	not injected
IW51L-03-10	21	28	23	16.5-23	6-13
IW51L-03-11	19.5	27	20	13-20	5-12
IW51L-03-12	18	25	20	13-20	5-12

bgs: below ground surface.

Variations in concentrations of VOCs in groundwater samples collected from three temporary groundwater sampling points (SB51L-02-3, SB51L-03-1, and SB51L-03-2a) located in the pilot test area are shown on Figure 12. Concentrations of VOCs initially decreased following the December injection, and then generally returned to pre-test levels. Results were inconclusive, however, since it could not be determined if the initial decreases were the result of oxidation of the VOCs or dilution from the injected fluids.

In March 2004, soil samples were collected from two borings (SB51L-04-1 and SB51L-04-2) to provide additional data to evaluate the effectiveness of the test. The locations of the borings are shown on Figure 13. The two borings were drilled adjacent to borings where soil samples had been collected prior to the pilot test, to compare pre-pilot test and post-pilot test soil concentrations. Concentrations of VOCs detected are listed in the following table. As shown on cross section C-C' (Figure 14), post-pilot-test concentrations of the primary site contaminants (PCE, TCE, and cis-1,2-DCE) are similar to or higher than pre-pilot-test samples, indicating that the pilot test was not effective.

Concentrations of VOCs Detected (mg/kg) in Soil Samples Collected from SB51L-04-1 and SB51L-04-2.

Boring Number	Depth (feet)	TCE	PCE	Cis-1,2-DCE	Trans-1,2-DCE	1,1-DCA	1,1-DCE	Other VOCs
SB51L-04-1	2	0.14	0.0086	0.027	ND	ND	ND	
	5	0.79	0.0083	1.9	0.2	0.03	0.014	Toluene=0.0094
	8.9	0.67	0.37	0.1	0.02	ND	ND	
	12.2	1.8	1.1	0.13	0.018	0.0051	ND	
	16.5	1.3	0.06	0.34	0.3	0.038	ND	
SB51L-04-2	3	0.1	ND	0.019	0.011	ND	ND	
	5	0.12	ND	0.012	0.0063	ND	ND	
	8.8	1.3	0.025	0.051	0.0066	0.017	0.0067	
	1.5	0.65	0.048	0.08	0.0076	0.012	ND	
	16.5	1.3	ND	0.14	0.031	0.012	0.0069	
	20.5	0.25	ND	0.16	0.06	0.062	0.015	

HRC® Pilot Test at Building 75

In January 2004, an HRC® pilot test was conducted southeast of Building 75A in the Building 75/75A area of groundwater contamination. HRC® was injected into four borings that were drilled upgradient from temporary groundwater sampling point SB75-02-1, where the highest concentrations of VOCs in groundwater have been detected. The locations of the injection points are shown on Figure 15. No changes were observed in the concentrations of VOCs detected in groundwater samples collected from SB75-02-1 and adjacent multi-level lysimeter SB75-96-2, indicating that the test was not effective.

Old Town Plume (Building 7 Lobe) - Soil Flushing Pilot Test

The soil flushing pilot test in the upgradient portion of the core of the Building 7 lobe of the Old Town groundwater plume continued. Approximately 2,000 to 3,000 gpd of treated groundwater is being injected into the injection wells. Some treated water has also been injected into a well located south of Building 53. Starting at the end of October, 2003, approximately 1,000 gpd of treated groundwater from the Building 46 treatment system has been discharged near the top of the Building 58 slope to flush the downslope core area of the Building 7 lobe. This water is captured at the Building 53/58 Slope Groundwater Collection Trench. Variations in concentrations of total VOCs in the three groundwater extraction wells (EW7-03-1, EW7-03-2, and EW7-03-3) located west of the injection trench are shown on Figure 16. Total VOC concentrations in MW58-00-12, located on the slope, have declined from approximately 100,000 µg/L to 50,000 µg/L. The concentration of total VOCs detected in extraction well EW7-03-3 has declined from approximately 37,000 µg/L to less than 8,000 µg/L. The concentration of total VOCs in the other two extraction wells have varied at levels of approximately 5,000 µg/L or less in EW7-03-2 and 1,000 µg/L or less in EW7-03-1. As of the end of March 2004, approximately 380,000 gallons of water had been extracted and treated from the three extraction wells.

On March 1, 2004, injection of treated groundwater was halted for 10 days. At the end of the period, groundwater samples were collected from the three extraction wells. The concentration of total VOCs in EW7-03-3 continued a declining trend and the concentrations of total VOCs in EW7-03-1 and EW7-03-2 did not show significant changes.

Thermally Enhanced Soil Vapor Extraction Pilot Test

Operation of the thermally enhanced soil vapor extraction pilot test continued. The heaters were previously rebuilt and three new dual phase (groundwater and soil gas) extraction wells were installed around the periphery of the test area. In order to improve the efficiency of vapor extraction, beginning on October 21, 2003, air was injected under pressure (8 to 10 psi) into the central (HG7-00-1) dual phase extraction well. Starting on October 29, 2003, the air was heated to approximately 180 degrees Celsius and injected at a pressure of about 30 psi.

Groundwater concentrations in the pilot test area have decreased. The variations in concentrations of total VOCs detected in groundwater samples collected from MW7B-95-21 are shown on Figure 17. The concentration of total VOCs in MW7B-95-21 has decreased to less than 1,000 µg/L, from an initial concentration of approximately 300,000 µg/L. Extracted vapor concentrations peaked at the start of hot air injection at approximately 7 grams/m^3 but have dropped substantially. Concentrations of VOCs in both groundwater and soil gas in samples collected from the dual-phase extraction wells have decreased significantly; however, concentrations of VOCs in soil-water samples collected from the two instrument wells remain high. The variations in concentrations of PCE detected in soil-water samples collected from HI7-00-1 are shown on Figure 18. Concentrations of PCE in the soil water below 15 feet remain in the range of 50,000 µg/L to 150,000 µg/L.

Building 51/64 Groundwater Solvent Plume Soil Flushing Pilot Test

Activities associated with the *in-situ* soil flushing pilot test in the Building 51/64 Groundwater Solvent Plume source area continued. Construction of both the injection and extraction trenches was completed. An automatic system was installed to pump the water from the collection trench and a new treatment system was constructed. The system consists of a 55-gallon granular activated carbon (GAC) unit and a 1000-pound GAC canister in series. The treated water is collected in a holding tank and then reinjected under pressure into the trench inside Building 64. Injection started on October 21, 2003. The water collected from the extraction trench is treated and recirculated to the injection trench. Treated water from the Building 51 Fire Trail system has also been injected into the trench at a rate of approximately 100 to 500 gallons per day. As of the end of March 2004, approximately 63,000 gallons of treated water have been injected into the trench inside Building 64 and 17,500 gallons of water extracted from the collection trench east of the building. Water levels in temporary groundwater sampling points SB64-03-5 and SB64-03-6, located south of the pilot test area, have been increasing.

Old Town Solvent Plume (Building 52 Lobe) Soil Flushing Pilot Test

An automatic system was installed to pump approximately 100 gallons of water per hour from the treatment system on the east side of Building 46 to a holding tank on the east side of Building 52. Since May 26, 2003, the treated water from the holding tank has been injected

primarily into MW52-98-9. The treated groundwater is being used to flush contaminants from the relatively high permeability Moraga Formation rocks in the source area of the Building 52 lobe of the Old Town Plume. The flushed groundwater is captured downgradient (northwest) of this area where the Building 52 lobe is intercepted by the Building 46 subdrain.

Building 51A/51L Area - Soil Flushing Pilot Test

An automatic system was installed at building 51A to extract contaminated groundwater from temporary groundwater sampling point SB51A-01-8B. The extracted water is treated at the Building 51L treatment system and injected into MW51-01-11. The purpose is to flush and extract the groundwater contaminants near SB51A-01-8B. The locations of the injection and extraction well are shown on Figure 11.

SURFACE WATER SAMPLING

Monthly surface water samples continued to be collected throughout the first and second quarters of FY 2004 from upstream and downstream locations on Chicken Creek and North Fork Strawberry Creek and analyzed for tritium. No tritium was detected (<300 pCi/L). The variations in concentrations of tritium detected in Chicken Creek in monthly sampling from April 2001 through March 2004 are shown on Figure 19.

In February 2004, annual surface water samples were collected from seven creeks flowing from LBNL and analyzed for VOCs, metals, and tritium. No VOCs or tritium was detected. Arsenic, barium, copper, molybdenum, nickel, and zinc were detected in most samples. Selenium, thallium, and vanadium were also detected. Concentrations of metals detected in each creek were consistent with previous results and are listed in the following table.

Concentrations of Metals Detected in Surface Water (μg/L)
February 2004

Creek	Sb	As	Ba	Be	Cd	Cr	Co	Cu	Pb	Hg	Mo	Ni	Se	Ag	Tl	V	Zn
North Fork Strawberry	<2	2.4	87	<1	<1	<3	<1	2.4	<1	<0.2	1.5	<2	1.1	<1	<1	10	21
Botanical Garden	<2	1.2	54	<1	<1	<3	<1	2.5	<1	<0.2	2.0	2.7	<1	<1	<1	<3	<5
Cafeteria	<2	1.0	77	<1	<1	<3	<1	2.3	<1	<0.2	2.5	2.5	<1	<1	<1	<3	13
Chicken	<2	2.0	46	<1	<1	<3	<1	8.2	<1	<0.2	1.8	<2	<1	<1	<1	5.4	40
No Name	<2	2.2	100	<1	<1	<3	<1	4.1	<1	<0.2	1.6	2.7	<1	<1	<1	<3	15
Ravine	<2	<1	75	<1	<1	<3	<1	<2	<1	<0.2	7.2	<2	<1	<1	<1	<3	<5
Ten Inch	<2	<1	89	<1	<1	<3	<1	2.7	<1	<0.2	<1	2.5	<1	<1	<1	<3	5.1

SOIL GAS AND INDOOR AIR SAMPLING

Concentrations of some VOCs measured inside Buildings 53 and 76 in 1999 were anomalously high relative to what would be estimated from the concentrations of VOCs that had been detected in the soil and groundwater near the buildings. The Human Health Risk Assessment therefore recommended that additional investigation be conducted to assess whether groundwater and/or soil contamination under the building constituted the source of the VOCs detected in indoor air. To address this recommendation, soil gas samples were collected from four locations beneath each building in March 2004. Twenty-four hour indoor air samples were collected from inside each building at the same time, near the previously sampled locations. The locations where the samples were collected are shown on Figure 20 and Figure 21 for Building 53 and Building 76, respectively. Concentrations of VOCs detected are listed in the following table. The only VOC detected in soil gas samples at a concentration above the ESL for shallow soil for commercial/industrial land use was PCE beneath both buildings.

Concentrations of VOCs Detected (µg/m^3) in Soil Gas and Indoor Air Samples Collected at Building 53

Sample Number	PCE	TCE	cis-1,2-DCE	1,1-DCE	carbon tet	1,1,1-TCA	chloroform	Freon-113
Soil Gas Samples								
B53-1	8000[b]	1600	84	17	94	ND	20	ND
B53-2	2800[b]	730	28	16	99	99	40	23
B53-3	1400[b]	230	6.3	8.5	93	ND	34	17
B53-4	1700[b]	330	20	ND	19	ND	5	ND
Indoor Air Sample								
B53 Air[a]	8	1.7	ND	ND	0.73	0.57	0.25	4.3
PEL[c]	690,000	553,000	790,000	not specified	64,000	1,900,000	240,000	7,600,000

(a) Concentrations shown only for analytes detected in soil gas.

(b) Concentration at or above the RWQCB Environmental Screening Level (ESL) for shallow soil gas for commercial/industrial land use.

(c) OSHA Permissible Exposure Limit (PEL) (8-hour time weighted average) except for chloroform which is ceiling limit.

ND: not detected.

Concentrations of VOCs Detected (µg/m^3) in Soil Gas and Indoor Air Samples Collected at Building 76

Sample Number	PCE	TCE	benzene	toluene	xylenes	1,1,1-TCA	trimethylbenzene		Freon	ethylbenzene	chloroform
							1,2,4	1,3,5			
Soil Gas Samples											
B76-1	49	ND	4	12	8.8	66	7.1	ND	170	ND	ND
B76-2	58	8.1	7.5	27	24	ND	6.1	ND	23	4.6	ND
B76-3	3700[b]	17	8.9	12	ND	51	ND	ND	291	ND	ND
B76-4	4200[b]	110	11	33	147	54	870	290	ND	14	9.4
Indoor Air Sample											
B76 Air[a]	8.6	7.9	7.5	64	49	1.3	9.8	2.8	9	9.7	0.27
PEL	690,000	553,000	3,250	766,000	435,000	1,900,000	124,750		4,950,000	435,000	240,000

(a) Concentrations shown only for analytes detected in soil gas.

(b) Concentration at or above the RWQCB Environmental Screening Level (ESL) for shallow soil gas for commercial/industrial land use.

(c) OSHA Permissible Exposure Limit (PEL) (8-hour time weighted average) except for chloroform which is ceiling limit.

ND: not detected.

The concentrations of benzene detected in the soil gas samples at Building 76 were at similar levels to the concentration detected in the indoor air sample and an order of magnitude lower than RWQCB Environmental Screening Level (ESL) for shallow soil for both residential and commercial/industrial land use. The benzene in the indoor air is therefore likely derived from the adjacent gas station operations.

OTHER ACTIVITIES

Reports

First Quarter FY2004

- LBNL submitted the semi-annual *Self-Monitoring Report* (for March 1 through September 8, 2003) for treated water discharged to the sanitary sewer to the East Bay Municipal Utility District (EBMUD) on October 7, 2003.

- LBNL submitted a *Permit Application* for the installation of temporary groundwater sampling points for the Building 51 subdrain source investigation to the City of Berkeley on October 23, 2003.

- LBNL submitted an *Interim Corrective Measures Workplan for Additional Soil Excavation in the Source Area of the Building 71 Solvent Plume* to the DTSC on November 14, 2003.

- LBNL submitted the *Quarterly Progress Report for the Third Quarter of FY03* to the DTSC on November 26, 2003, in compliance with LBNL's RCRA Part B Permit.

- LBNL submitted a *Workplan for Investigation of the Slope East of Building 64* and *Permit Application* to install two temporary groundwater sampling points for the investigation to the City of Berkeley on December 4, 2003. The workplan was submitted to the regulators on December 11, 2003.

Second Quarter FY2004

- LBNL submitted a *Workplan for Pilot Testing Hydrogen release Compounds (HRC) in the Building 75/75A Area* to the DTSC on January 5, 2004.

- LBNL submitted the *Risk-Based End State Vision Document (Version 2)* to the DOE on January 23, 2004. Copies of the document were distributed to the regulatory agencies and also made available for public review in the Information Repositories.

- LBNL submitted a *Permit Application* for the installation of temporary groundwater sampling points north of Building 7 and south of Building 51, and four groundwater extraction wells east of Building 53 to the City of Berkeley on February 27, 2004.

- LBNL submitted the *Quarterly Progress Report and Annual Status Summary for the Fourth Quarter of FY03* to the DTSC on February 27, 2004, in compliance with LBNL's RCRA Part B Permit.

- LBNL submitted the semi-annual *Self-Monitoring Report* (for September 9, 2003 through March 29, 2004) for treated water discharged to the sanitary sewer to EBMUD on February 29, 2004.

Meetings

First Quarter FY2004

- Remedial Project Managers meetings were held at the DTSC offices on October 9, November 13, and December 18, 2003. Representatives of the DTSC, RWQCB, DOE, and LBNL attended all meetings, except for the December meeting at which an RWQCB representative was not present.

- The DTSC held a public workshop on the status of the RCRA Corrective Action Process on October 28, 2003.

- The Semi-Annual Review Meeting was held on October 29, 2003. Attendees included representatives from the DTSC, RWQCB, City of Berkeley, City of Oakland, DOE, UC Office of the President, and LBNL.

- LBNL presented the semi-annual summary of field activities (April 1 to September 30, 3003) to the City of Berkeley Community Environmental Advisory Commission (CEAC) and community members on November 6, 2003.

Second Quarter FY2004

- A Remedial Project Managers meeting was held at the DTSC offices on March 18, 2004. Representatives of the DTSC, DOE, and City of Berkeley attended.

PLANNED ACTIVITIES

Following is a list of activities planned for the third and fourth quarters of fiscal year 2004 (April 1, 2003 to September 30, 2004):

New or Modified ICMs and Pilot Tests

- Excavate additional PCB-contaminated soil at the Building 88 hydraulic Gate Unit.

Ongoing ICMs and Pilot Tests

- Continue monitoring the *in-situ* chemical oxidation pilot tests at Building 71B and at Building 51L.

- Continue the thermally enhanced soil vapor extraction pilot test at Building 7.

- Continue monitoring the pilot test of Hydrogen Releasing Compounds (HRC®) at Building 71B.

- Continue groundwater extraction and treatment from the collection trench in the source area of the Old Town plume north of Building 7, in the source area west of Building 25A, in the downgradient areas of the Old Town VOC plume west of Building 58 and southeast of Building 58, and at the Building 46 subdrain.

- Continue recirculation of the treated water extracted from the Building 7 Collection Trench.

- Continue injection of treated groundwater into the wells in the core area of the Building 7 lobe of the Old Town plume and extraction from the three downgradient extraction wells.

- Continue injection of treated groundwater into wells east of Building 52 in the core area of the Building 52 lobe of the Old Town plume.

- Continue recirculation of treated groundwater in the source area of the Building 51/64 Groundwater Solvent Plume.

- Continue operation of the Building 53/58 slope dual-phase-extraction system in the Old Town VOC Plume core area.

- Continue operation of the dual-phase-extraction system for the diesel plume north of Building 6.

- Continue operation of the groundwater extraction and treatment system at Building 51L and the Building 51A catch basin.

- Continue extraction of contaminated groundwater from temporary groundwater sampling point SB51L-01-8B and injection into MW51-01-11 inside building 51A.

- Continue extraction and treatment of groundwater from the Building 51/64 plume source area excavation.

Other Planned Activities

- Submit the *Draft* Corrective Measures Study Report to the DTSC.

- Submit the Quarterly Progress Reports for the first and second quarters of FY04 to the DTSC.

- Conduct quarterly groundwater sampling.

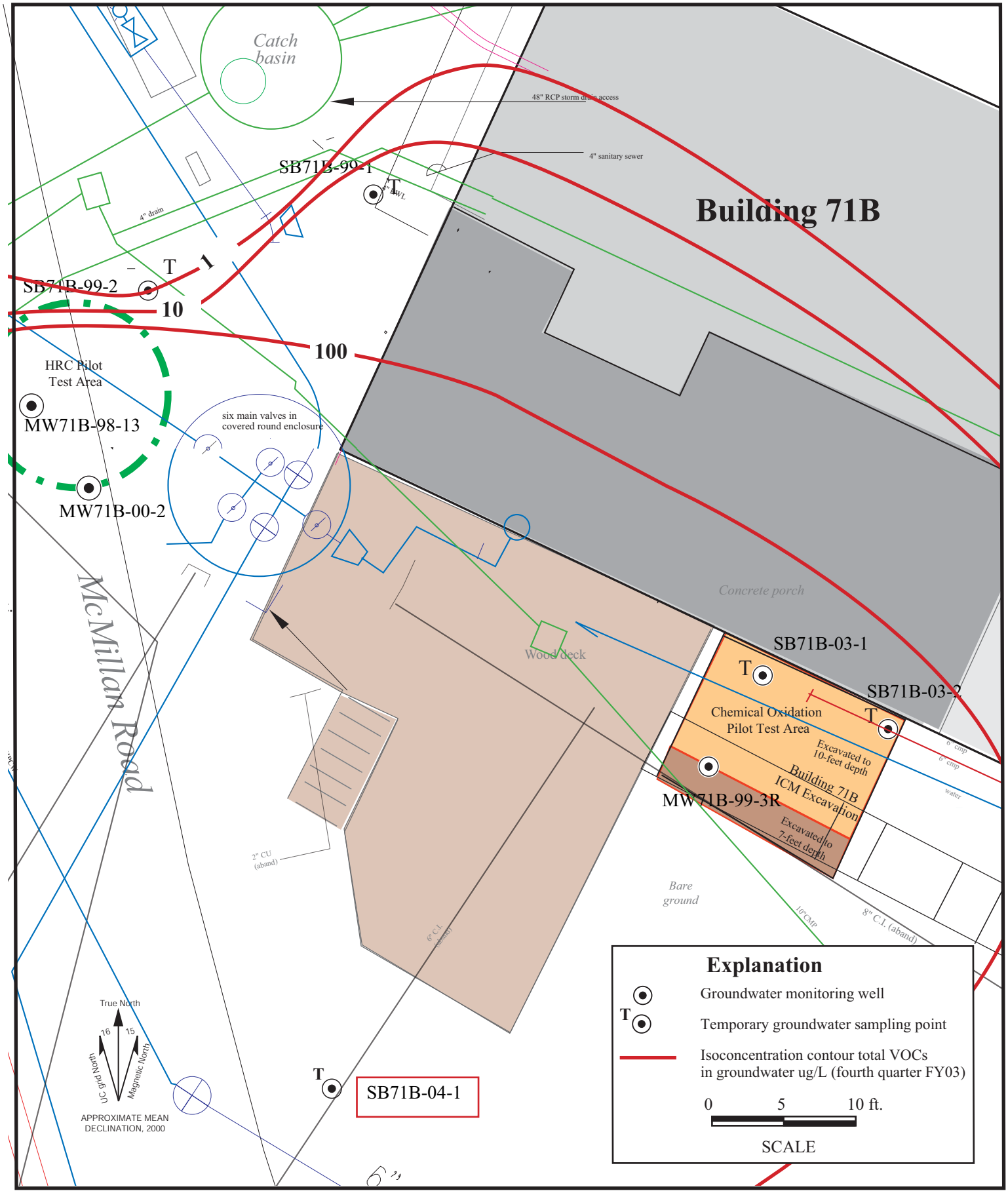

Figure 1. Location of Temporary Groundwater Sampling Point SB71B-04-1.

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4/04

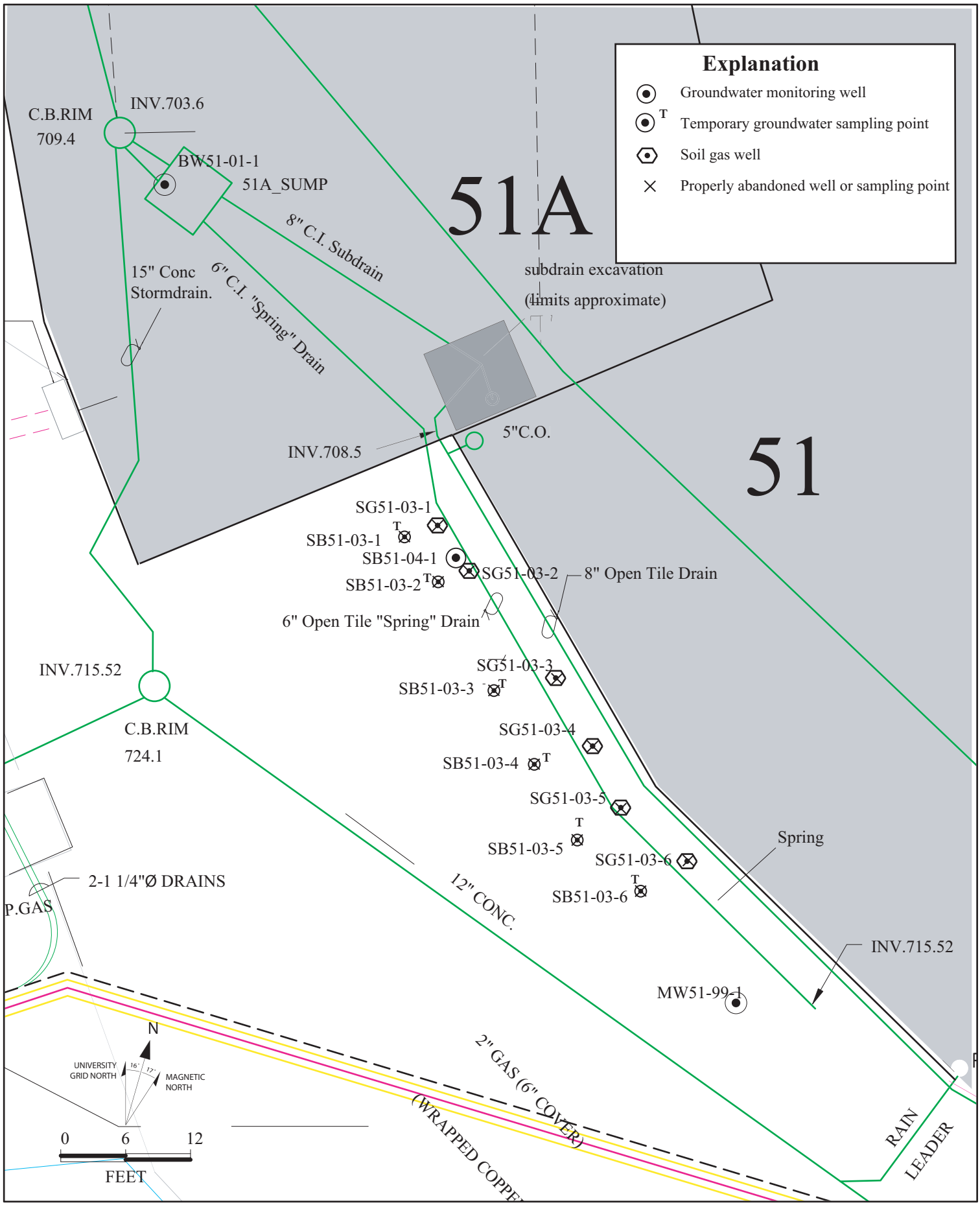

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Figure 2. Locations of Temporary Groundwater Sampling Point SB51-04-1 and Abandoned Temporary Groundwater Sampling Points SB51-03-1 to SB51-03-6 and Soil Gas Sampling Points SG51-03-1 to SG51-03-6.

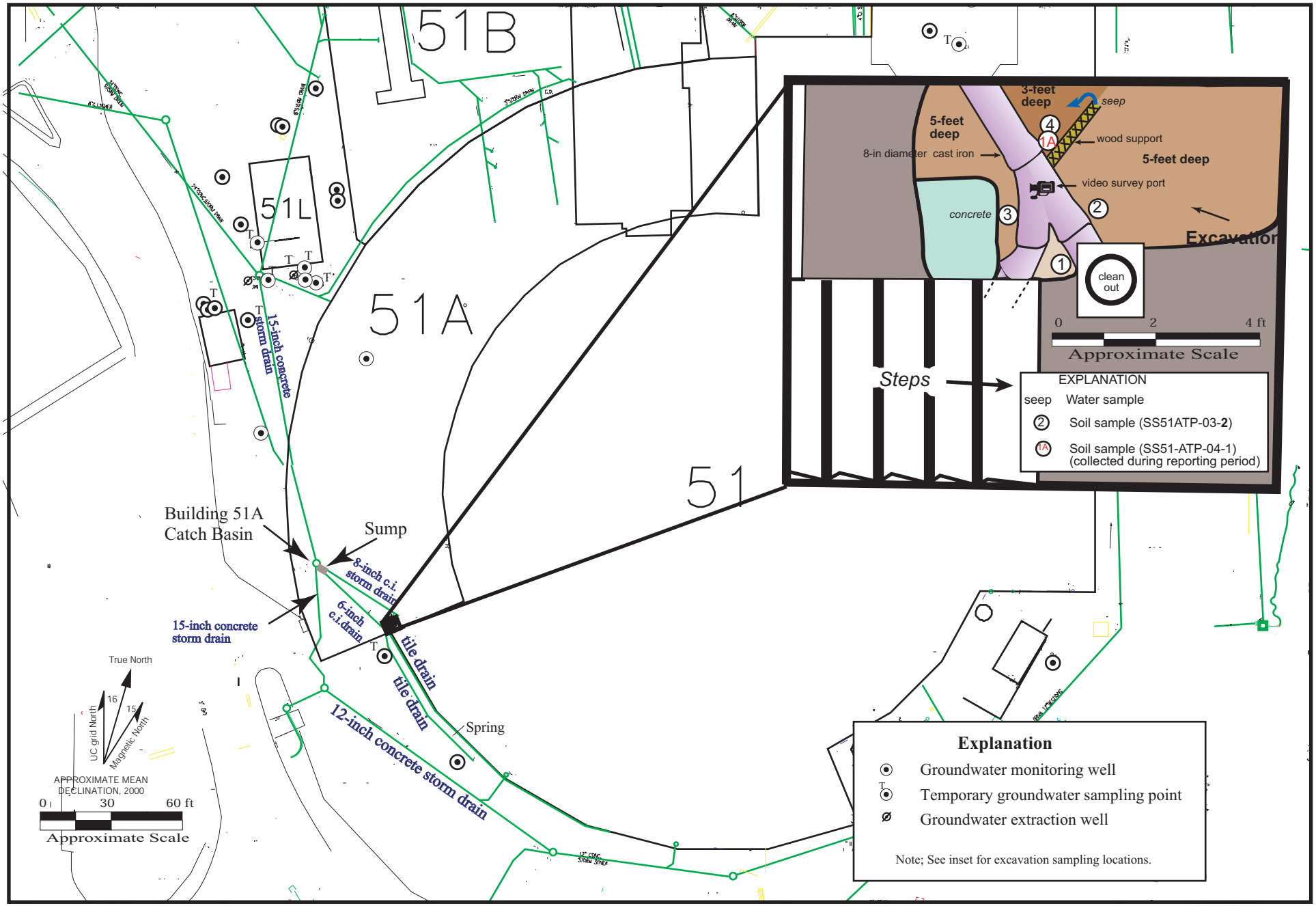

Figure 3 Building 51A Catch Basin Area Sampling Locations.

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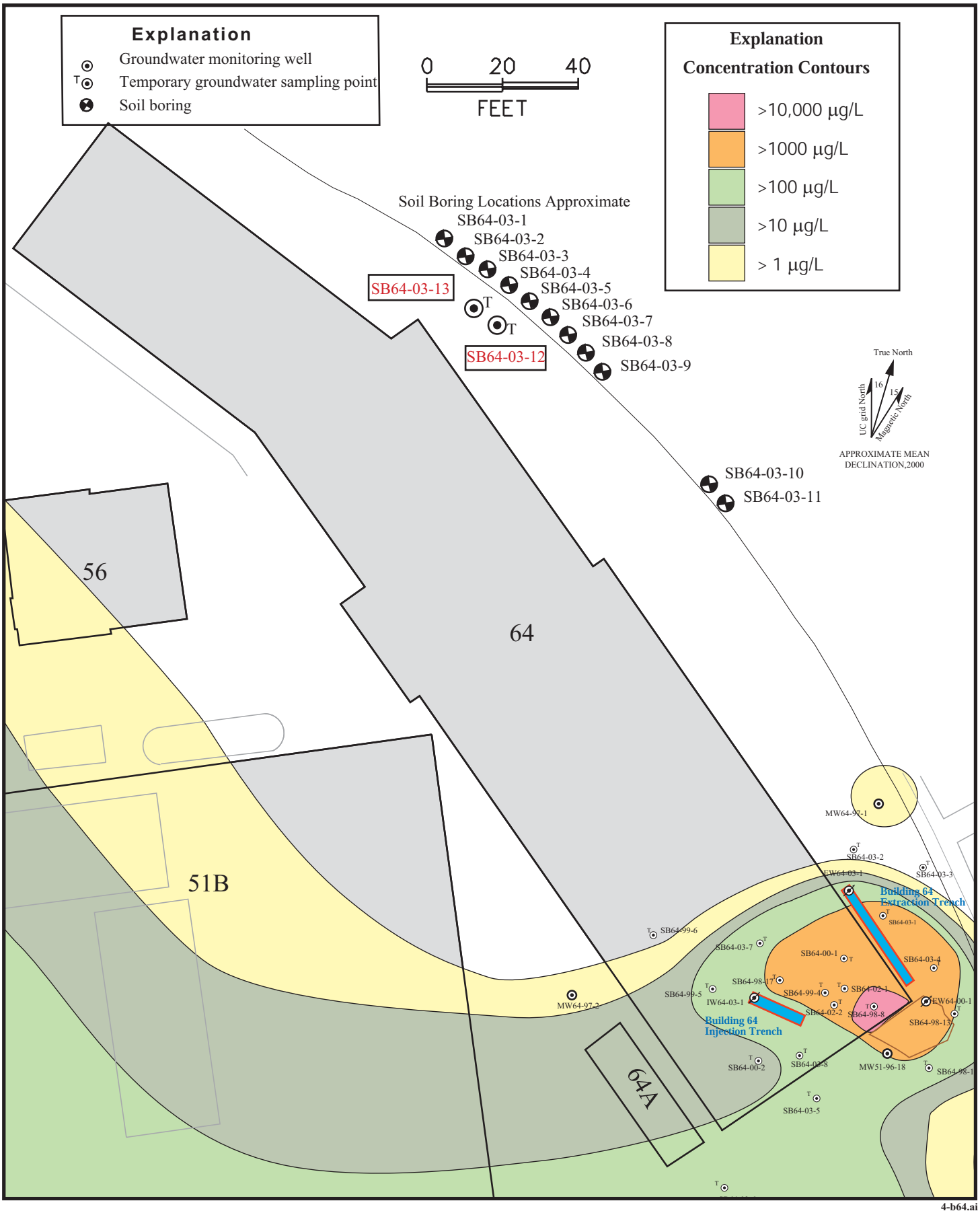

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Figure 4. Locations of Soil Borings SB64-03-1 through SB64-03-11 and Temporary Groundwater Sampling Points SB64-03-12 and SB64-03-13.

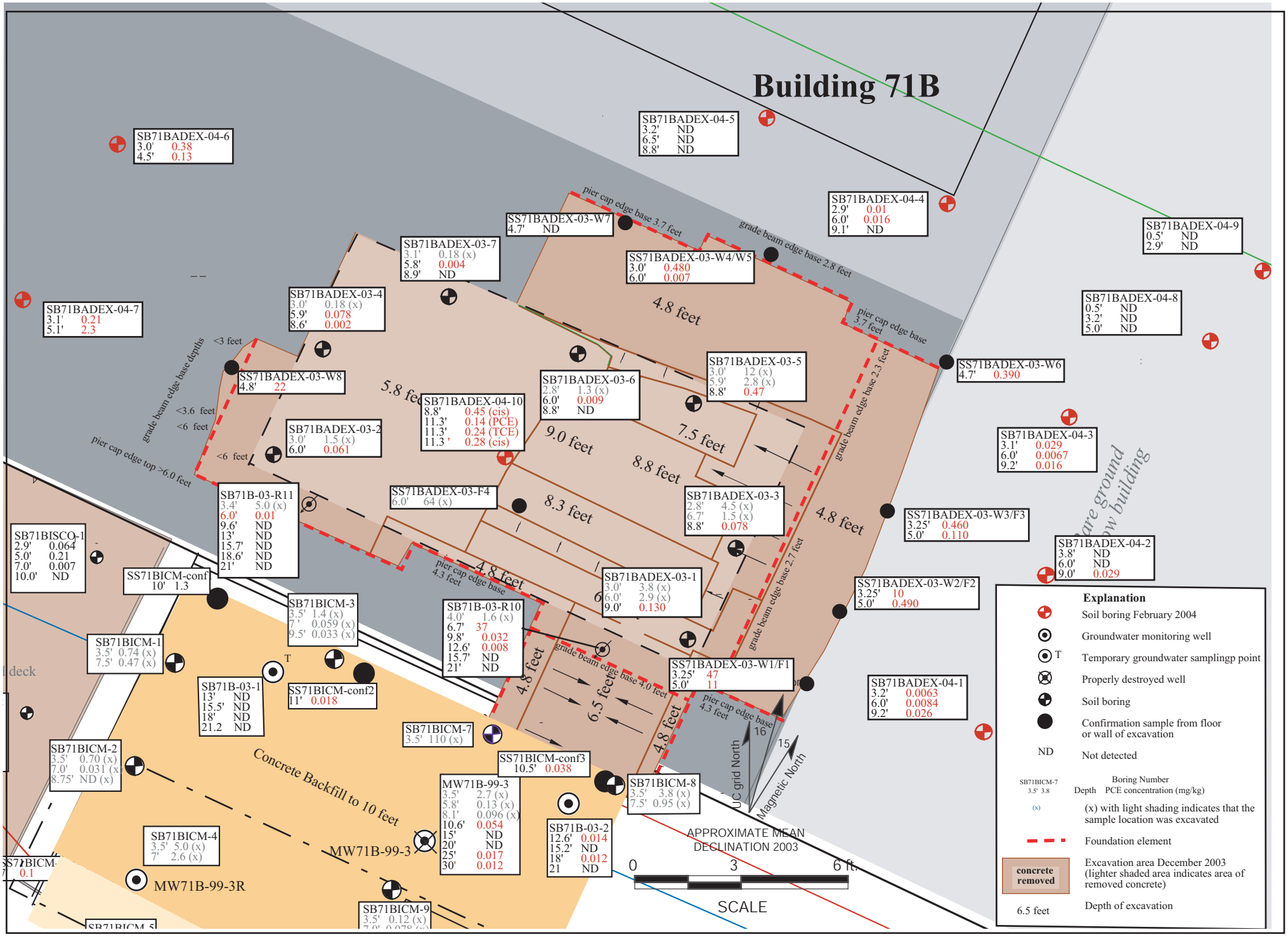

Figure 5 Concentrations of PCE Detected in Soil Samples, Building 71B Lobe Source Area.

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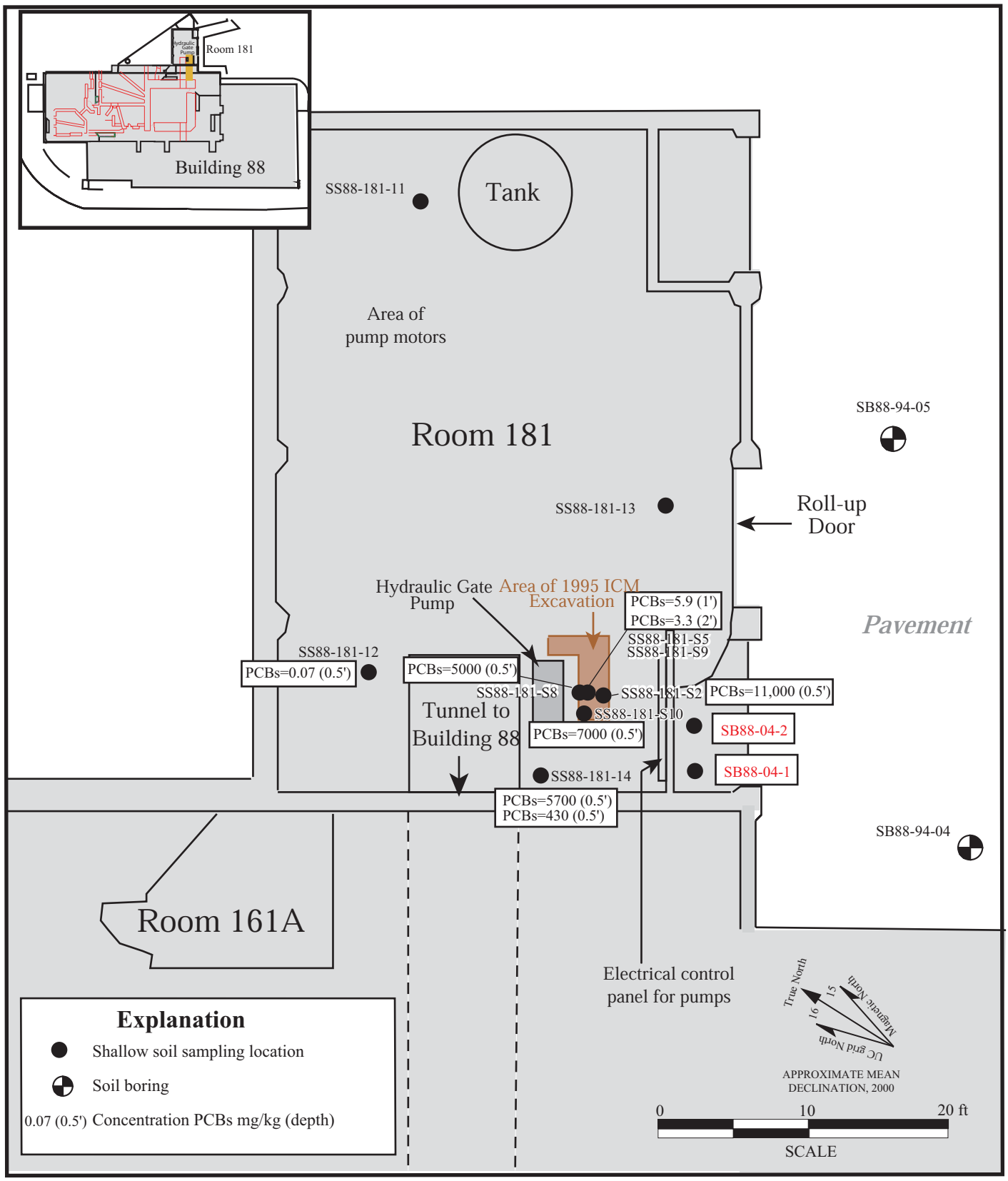

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Figure 6. Locations of Soil Borings SB88-04-1 and SB88-04-2 and Concentrations of PCBs Detected (mg/kg) Building 88 Hydraulic Gate Unit (AOC 6-3) .

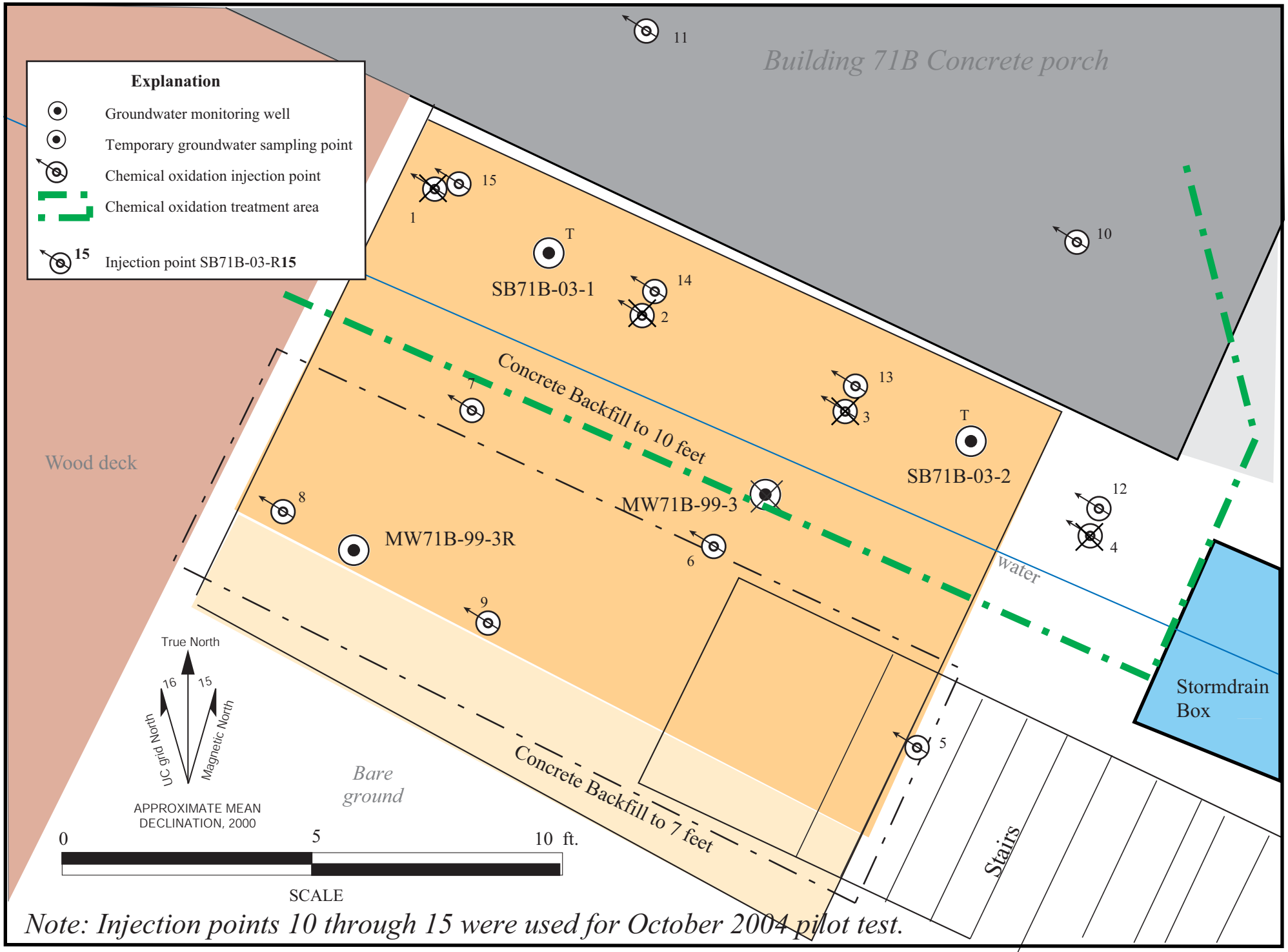

Figure 7 . Locations of In-Situ Chemical Oxidation Injection Points at Buillding 71B.

7-71B ISCO map test2.ai
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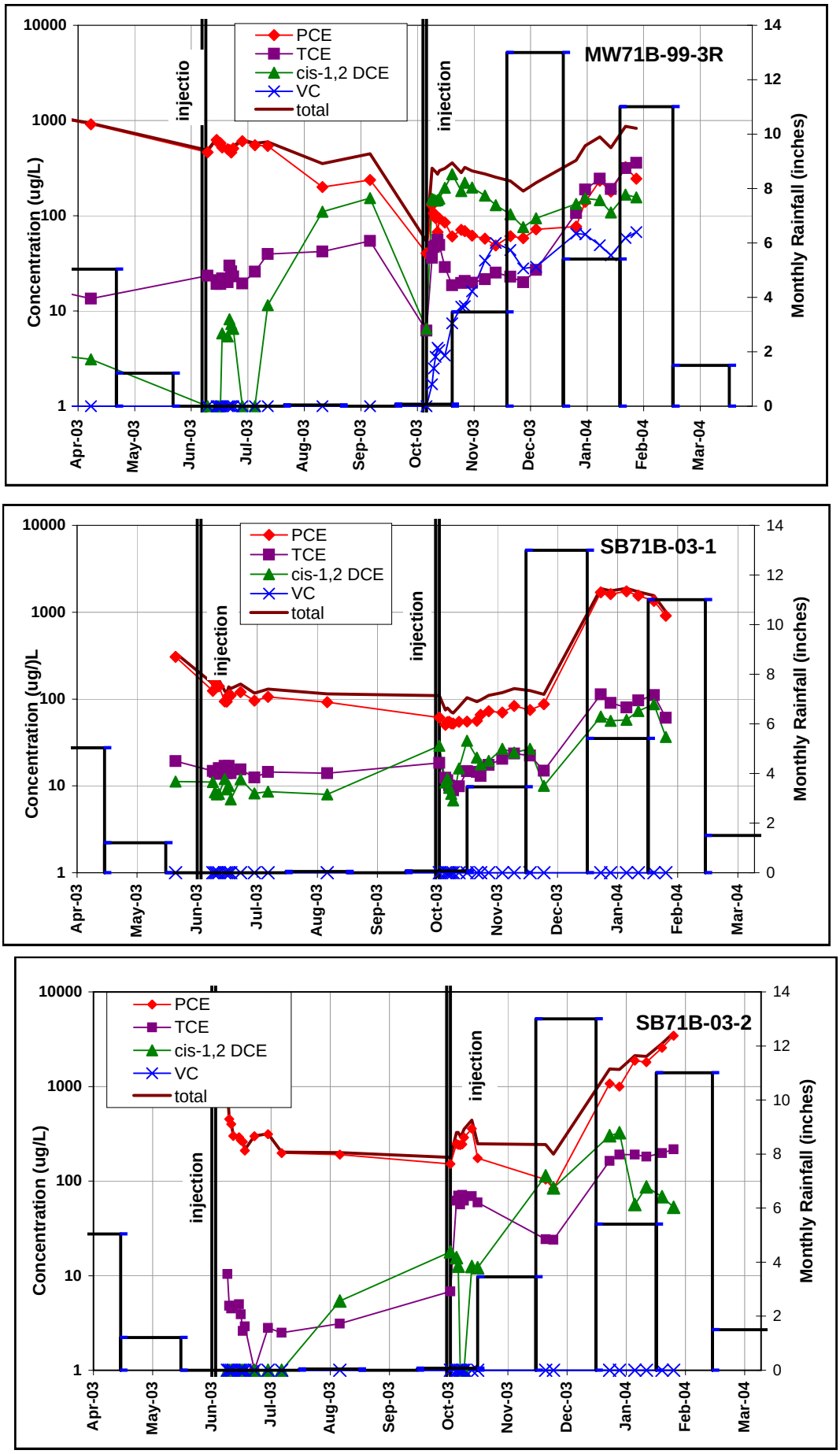

Figure 8. Variations in the Concentrations of VOCs Detected in Groundwater Samples Collected in the Building 71B In-Situ Chemical Oxidation Pilot Test Area.

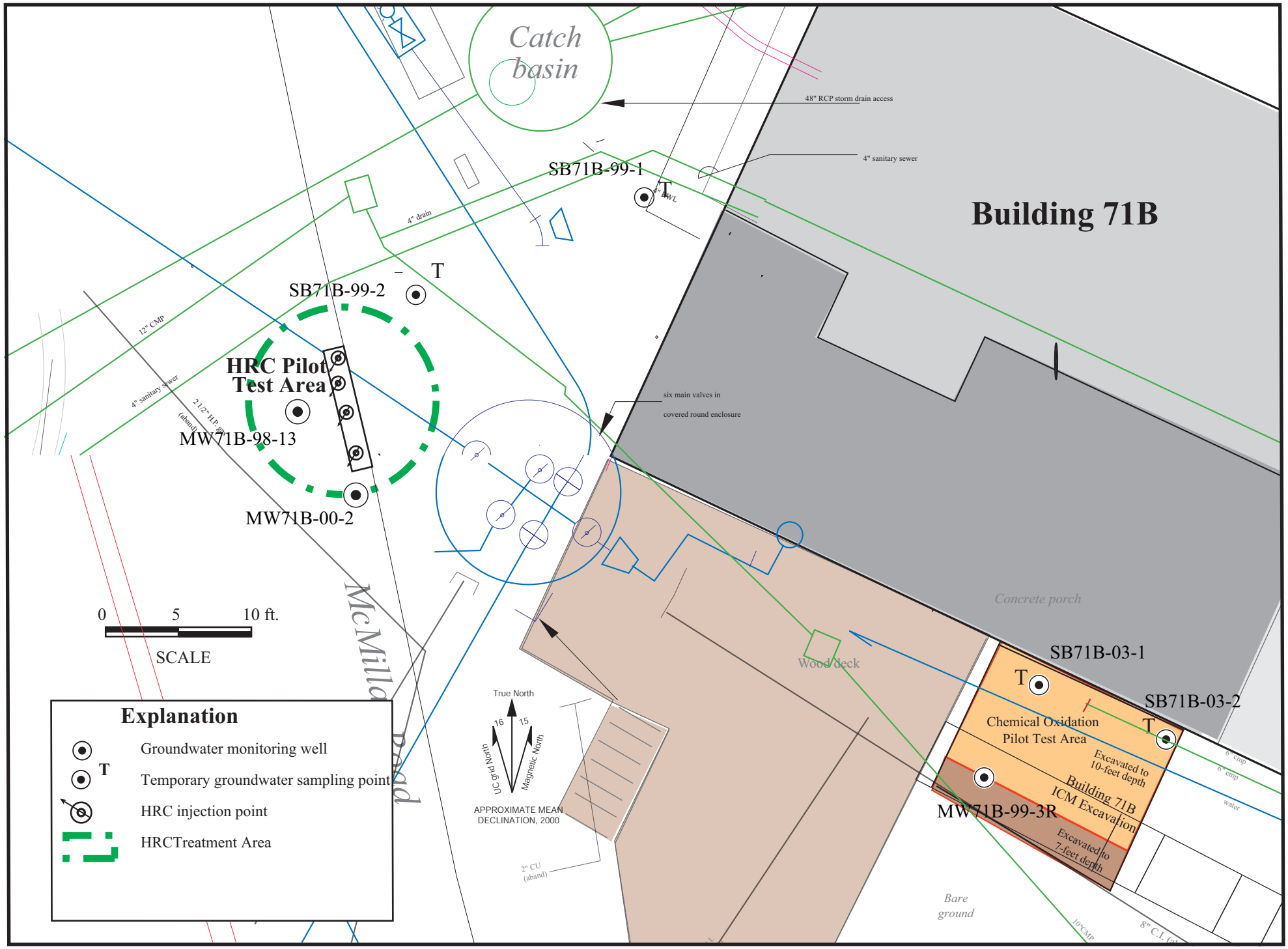

Figure 9. Location of Hydrogen Release Compound (HRC) Pilot Test Building 71B Lobe Core Area.

9-71B HRC sitemap.ai
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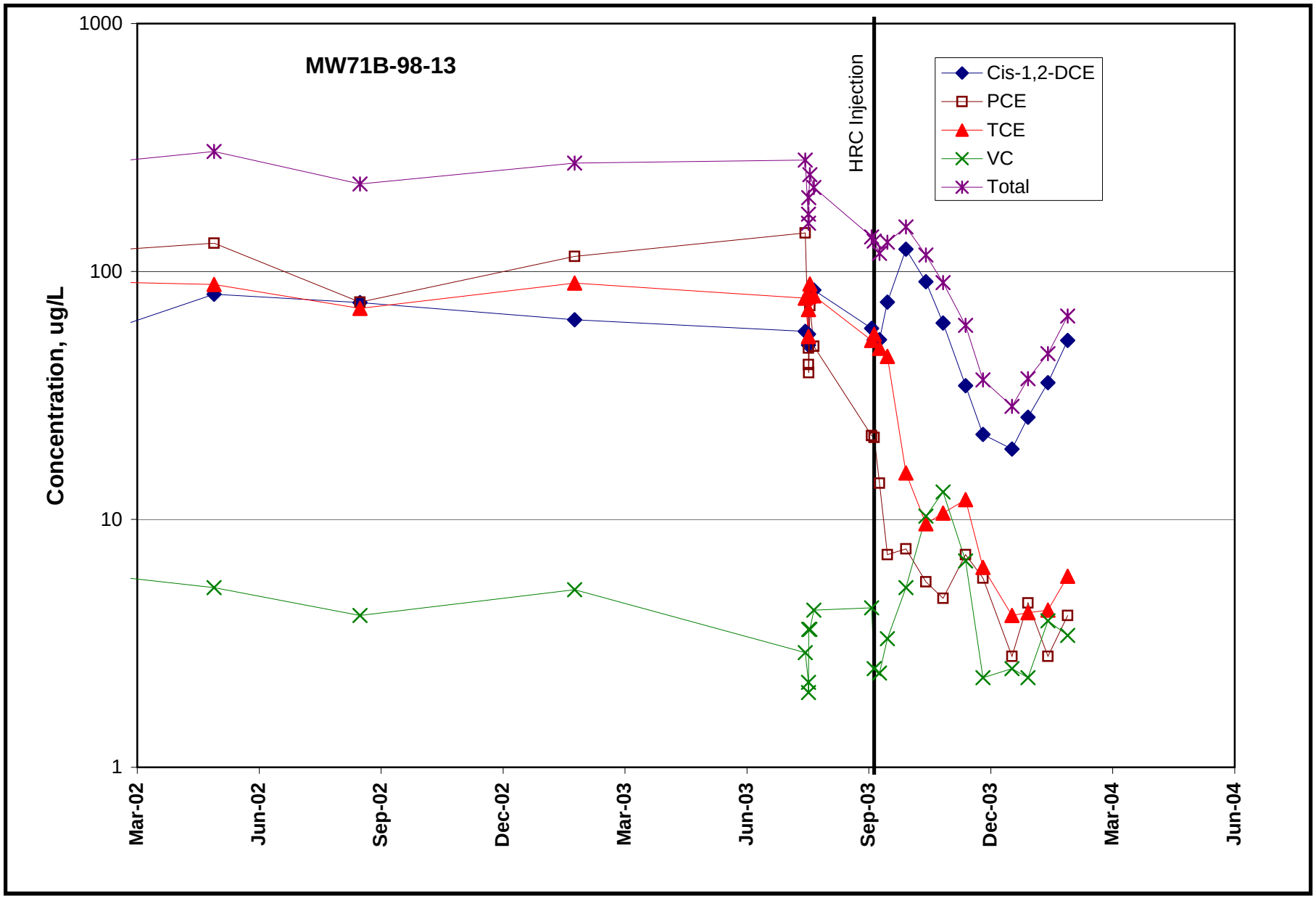

Figure 10. Concentrations of VOCs Detected in Groundwater, Building 71B HRC Pilot Test.

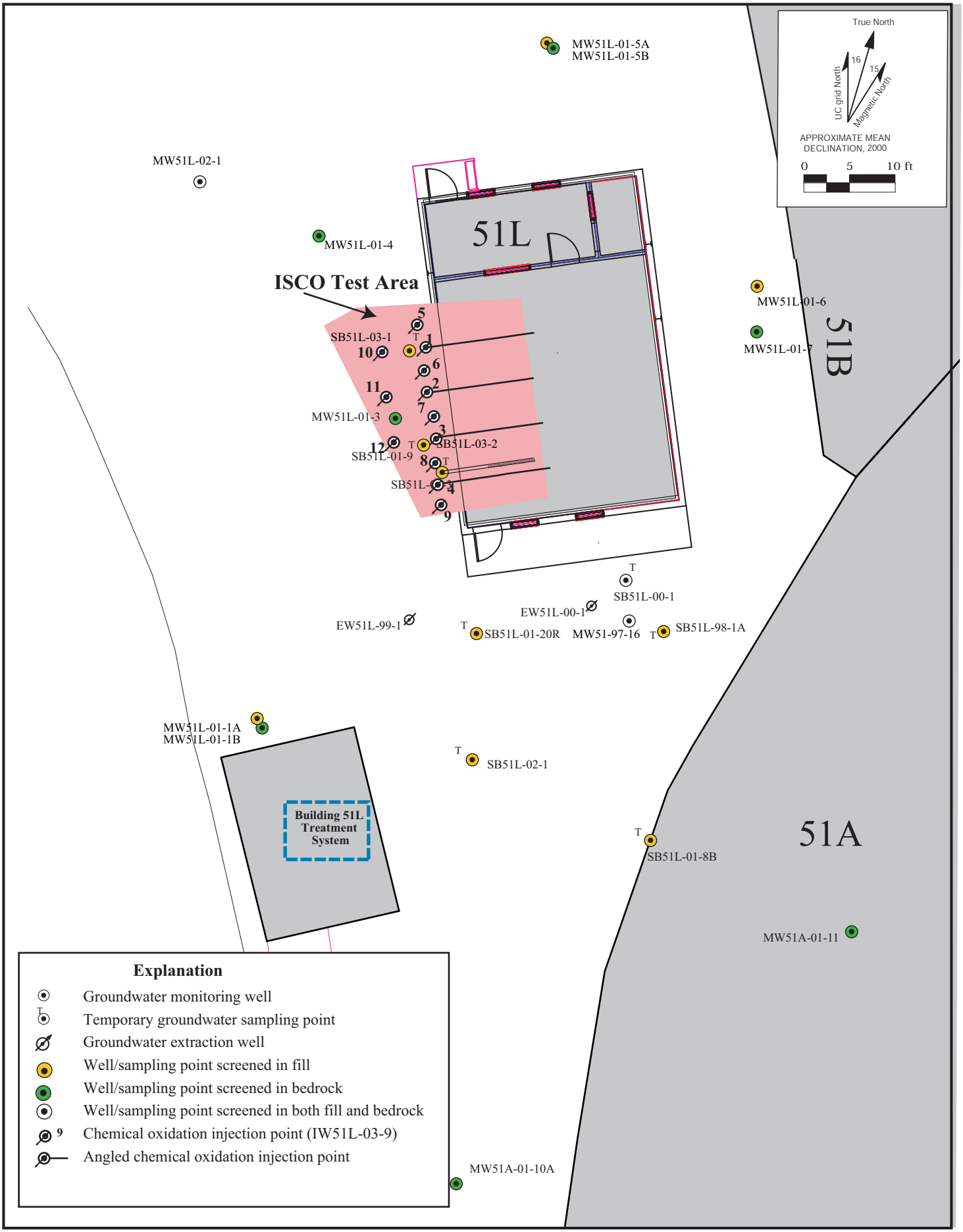

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Figure 11. Locations of In Situ Chemical Oxidation (ISCO) Pilot Test Area at Building 51L.

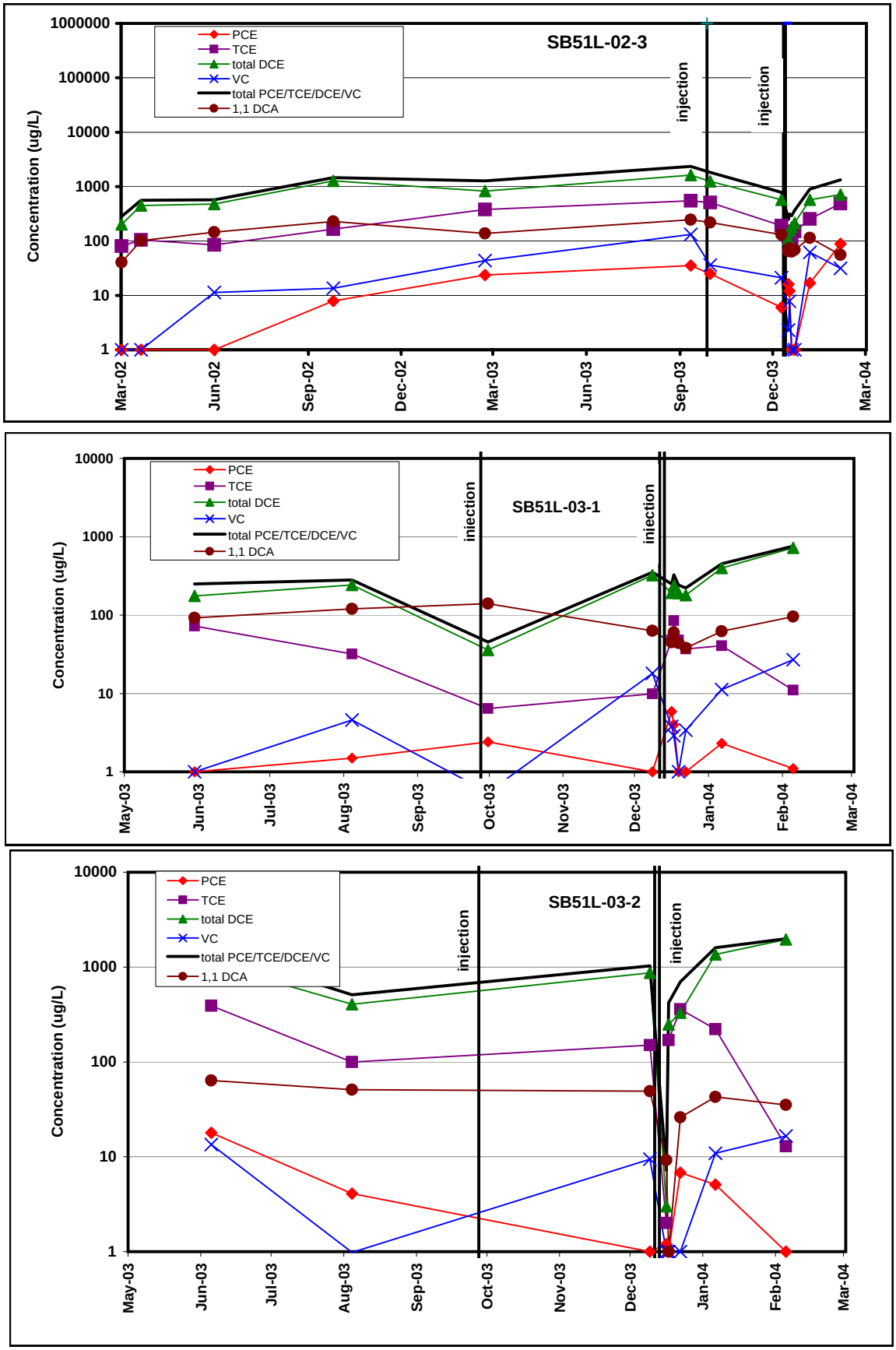

Figure 12. Concentrations of VOCs Detected in Groundwater Building 51L Chemical Oxidation Pilot Test.

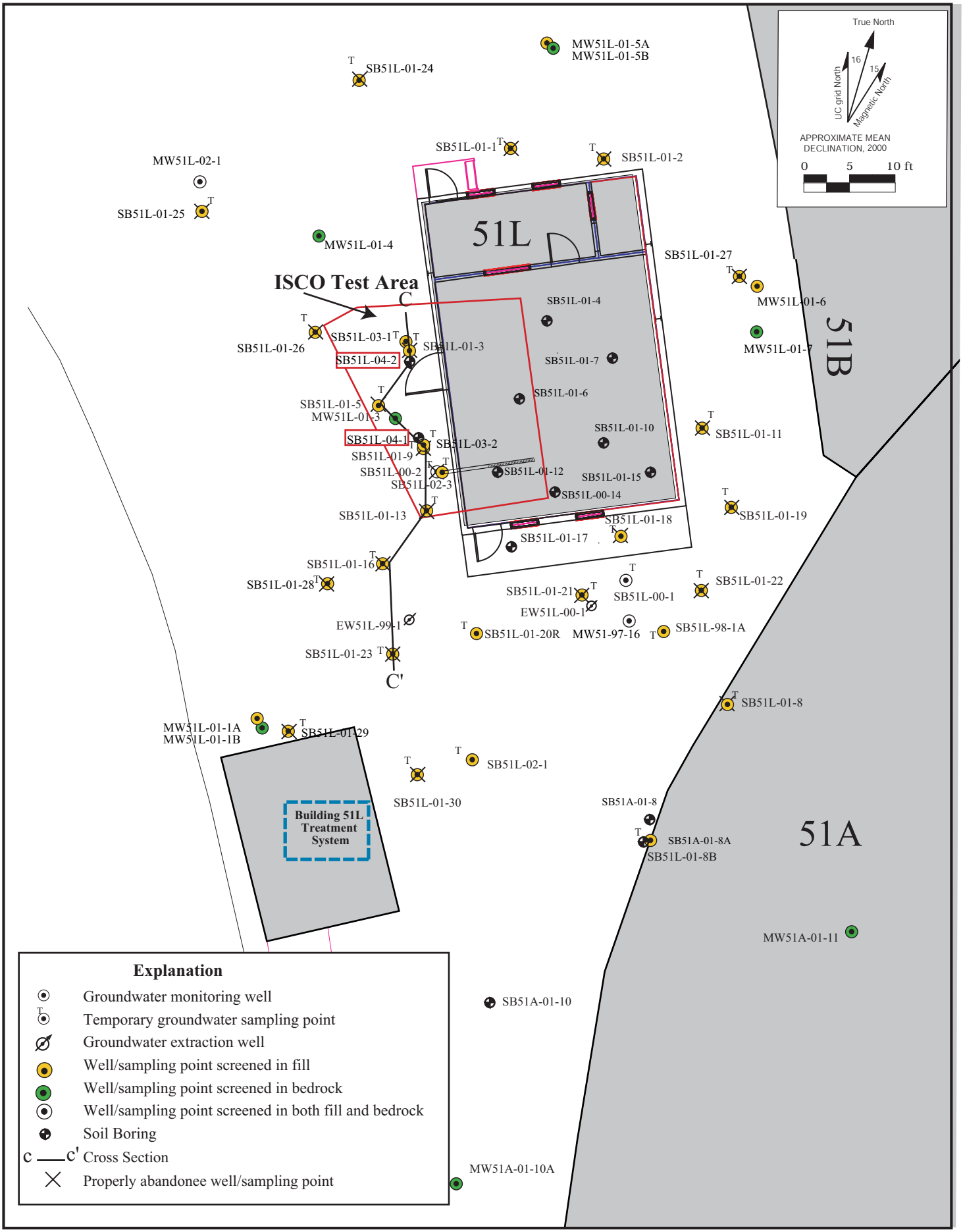

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Figure 13. Locations of Cross Secion C-C' and New Borings SB51L-04-1 and SB51L-04-2 In Situ Chemical Oxidation (ISCO) Pilot Test Area at Building 51L.

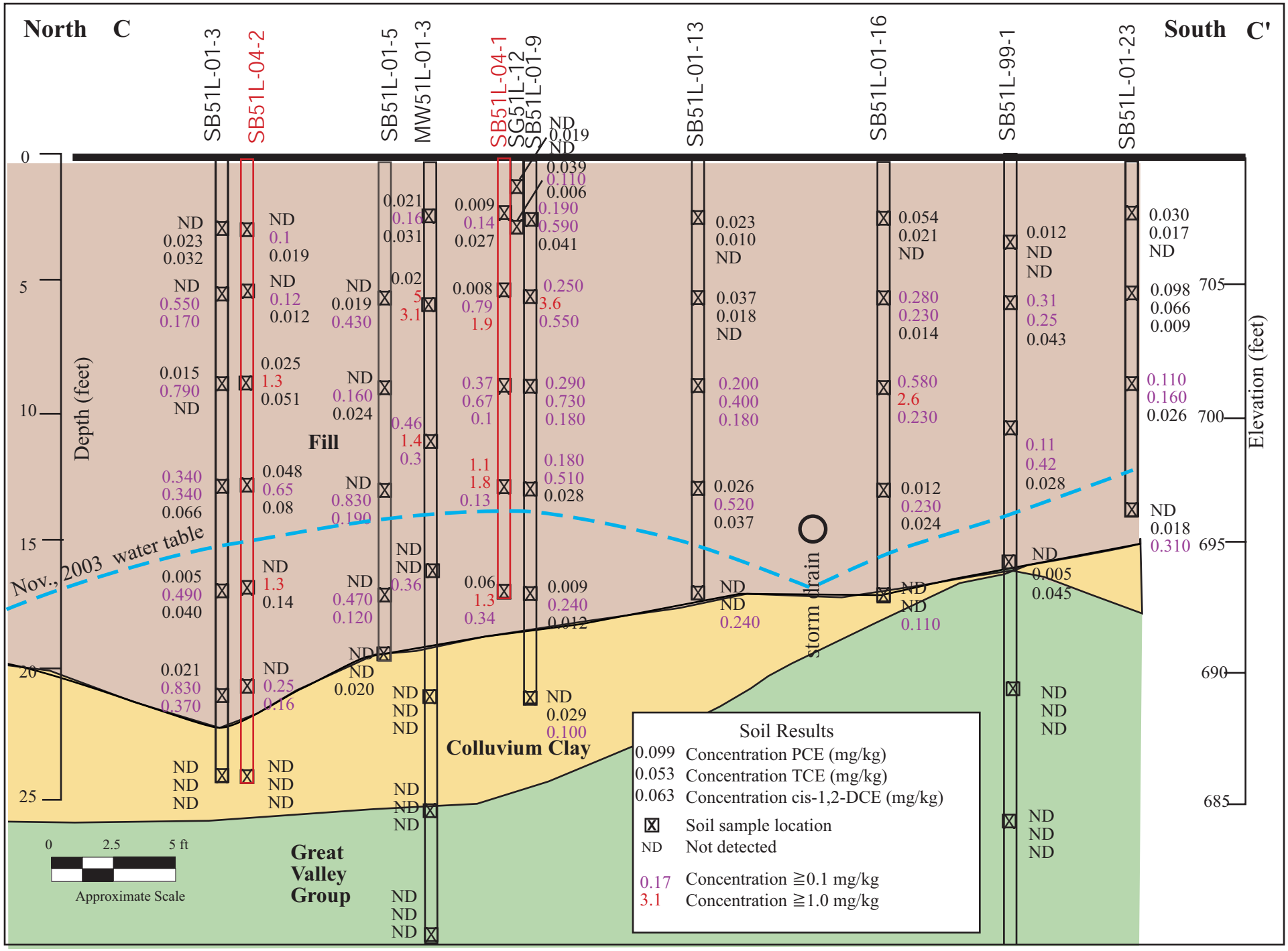

Figure 14. Cross section C-C' Building 51L Area Showing Concentrations of PCE, TCE and cis-1,2-DCE in soil (mg/kg).

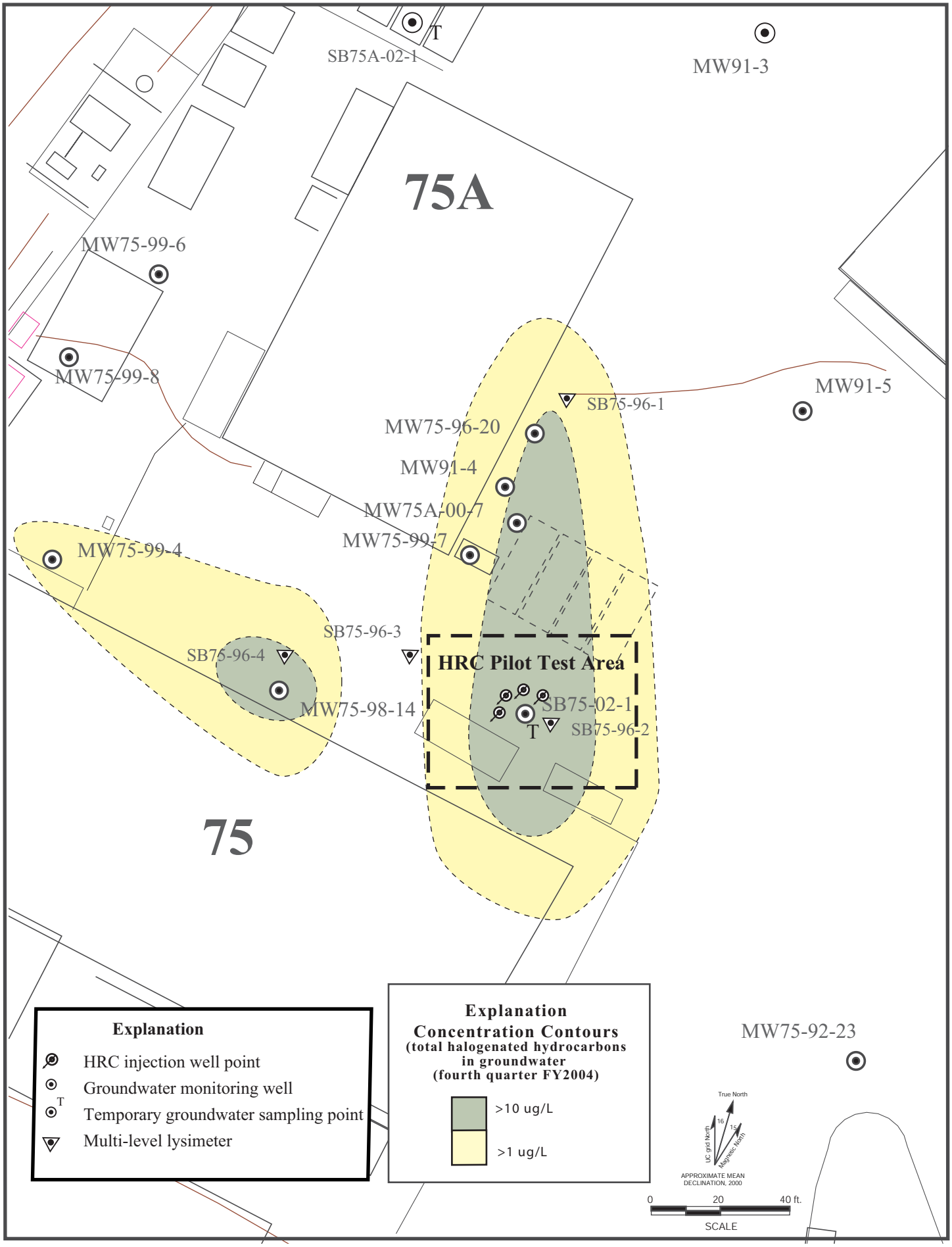

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Figure 15. Site Map Building 75/75A HRC Pilot Test.

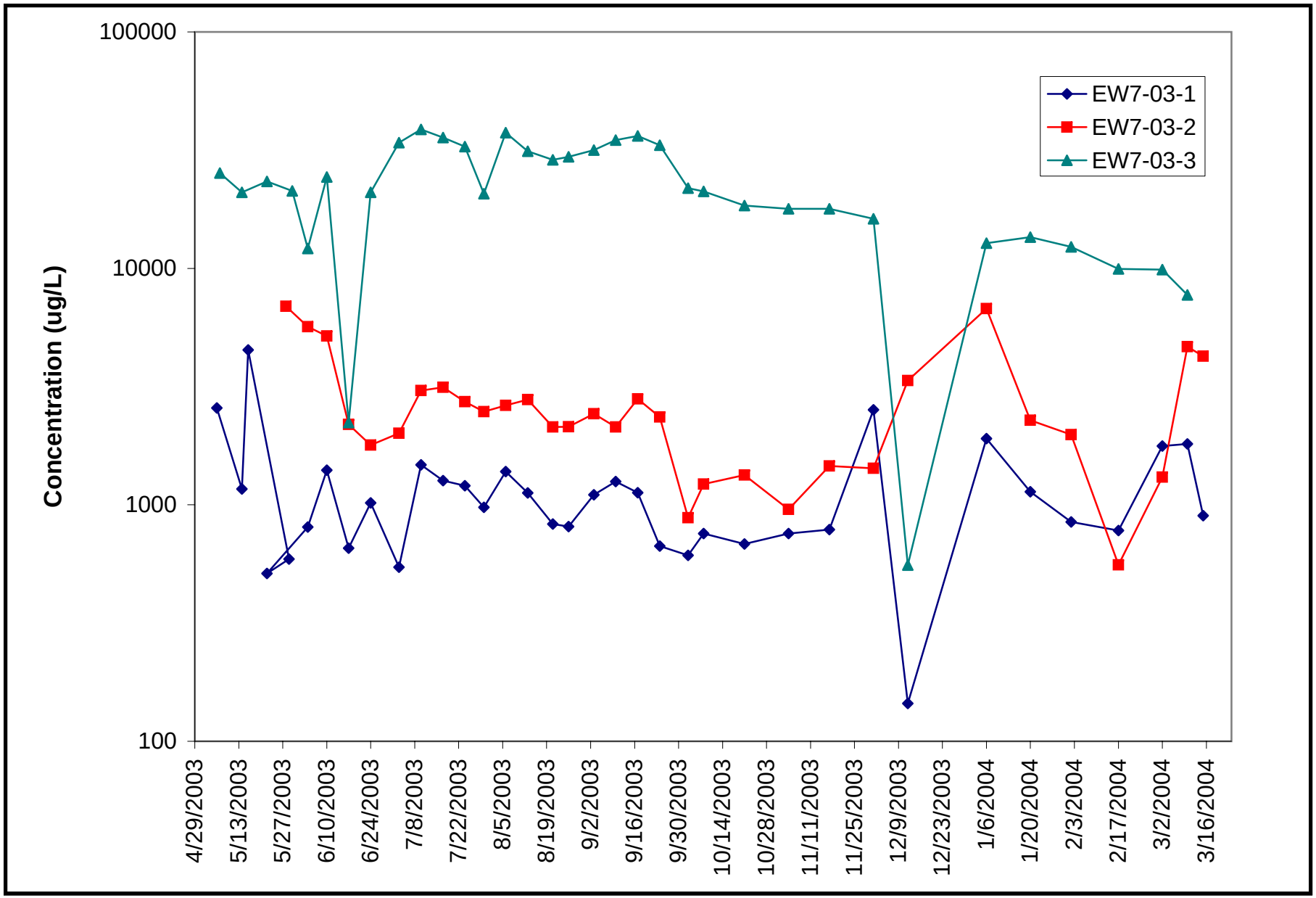

Figure 16. Concentrations of Total VOCs in EW7-03-1, EW7-03-2, and EW7-03-3.

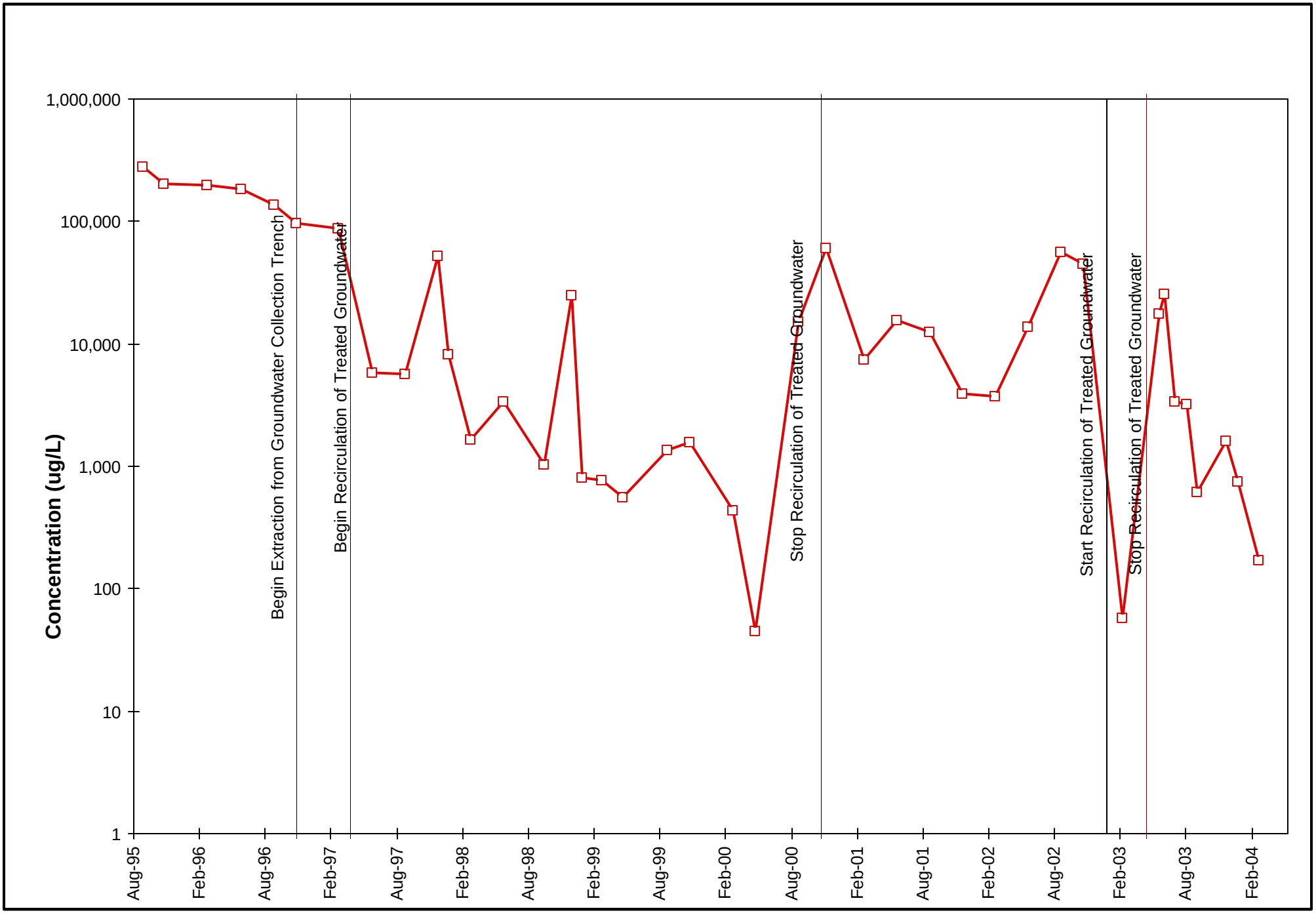

Figure 17. Concentration Trends for Total Halogenated VOCs in Groundwater Monitoring Well MW7B-95-21.

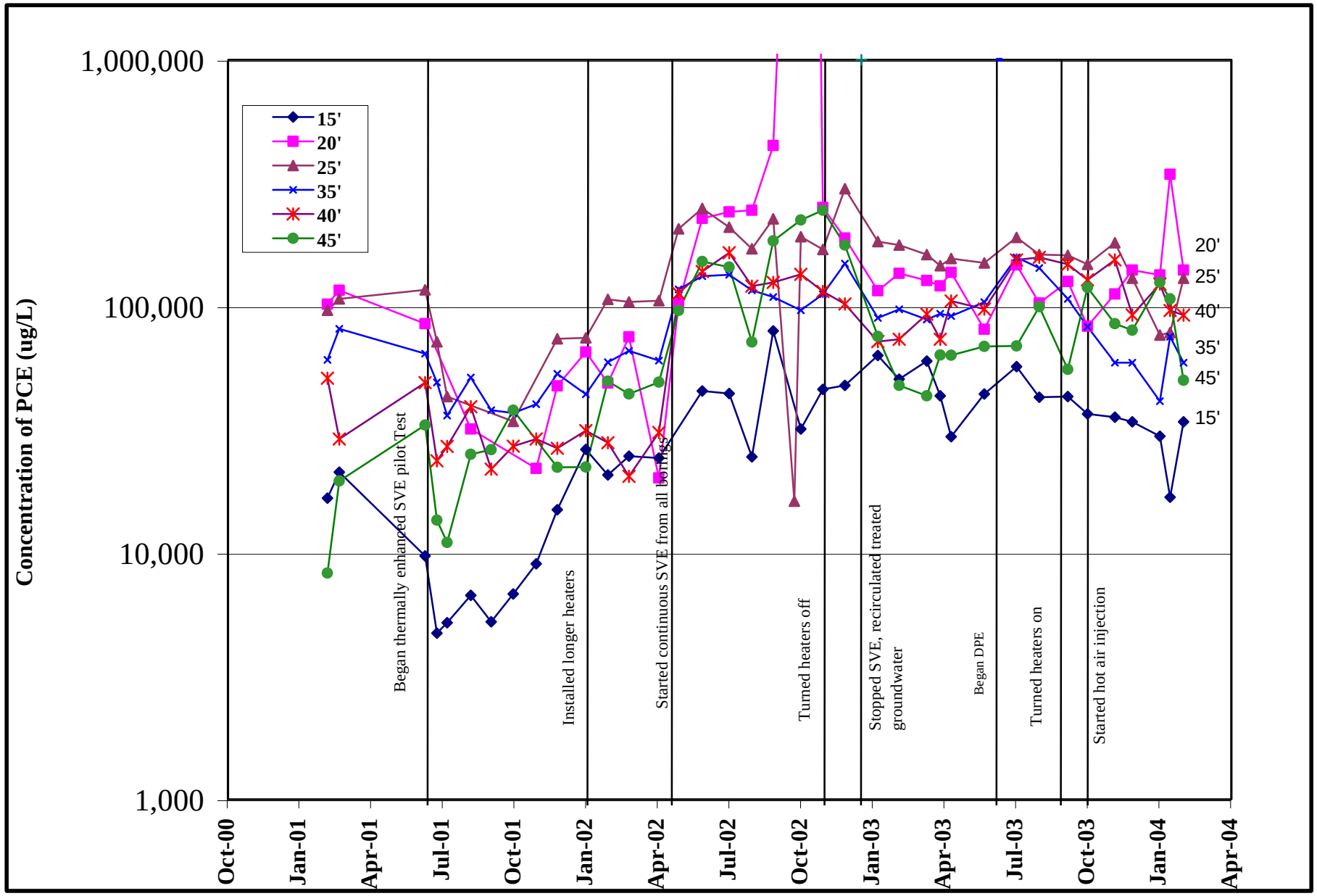

Figure 18. Concentration of PCE in Soil Water at HI7-00-1

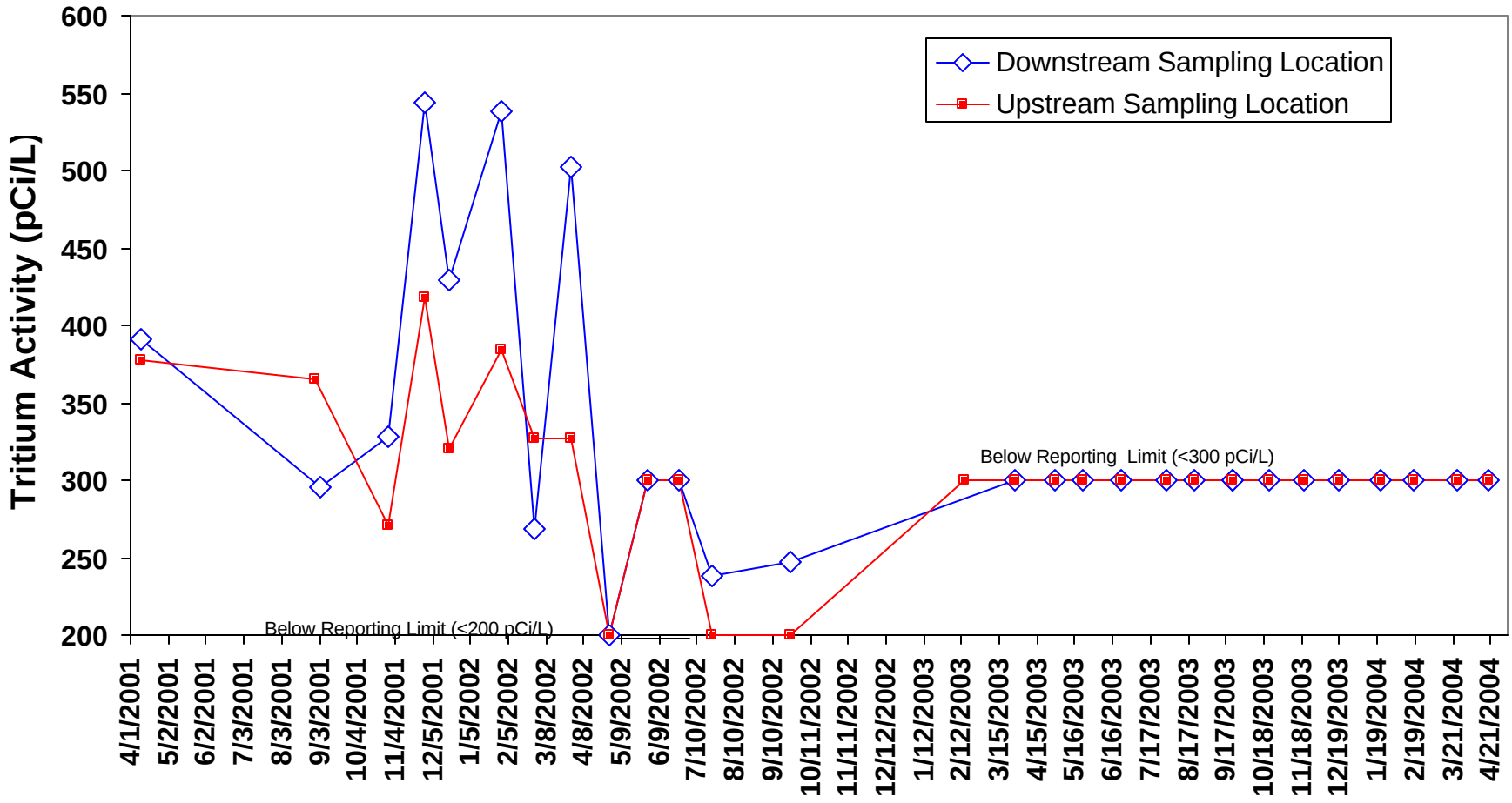

Figure 19. Tritium Activity Detected in Chicken Creek in Monthly Sampling (2001 to 2004).

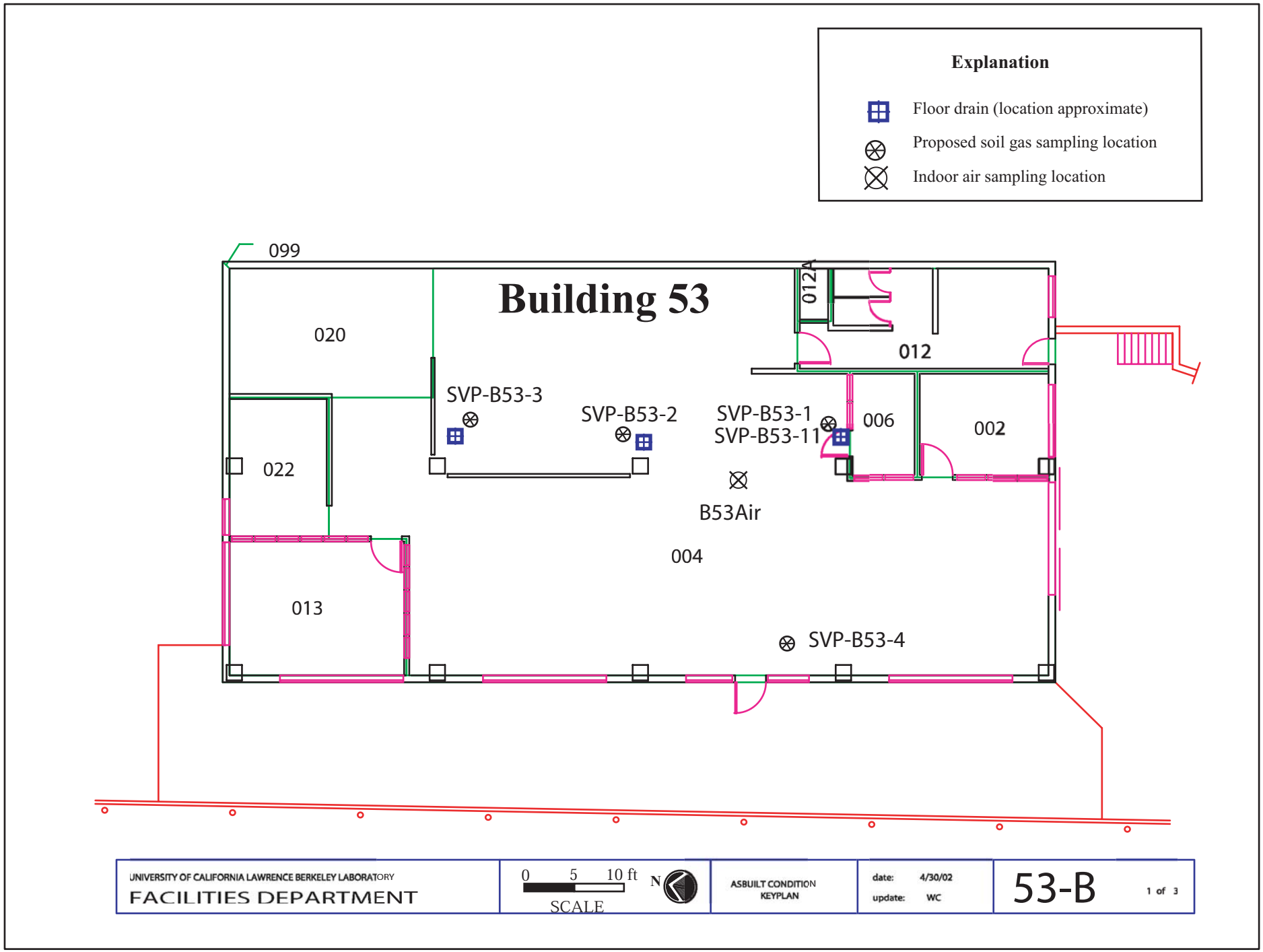

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Figure 20. Locations of Soil Gas Sampling Points and Indoor Air Sampling Location inside Building 53.

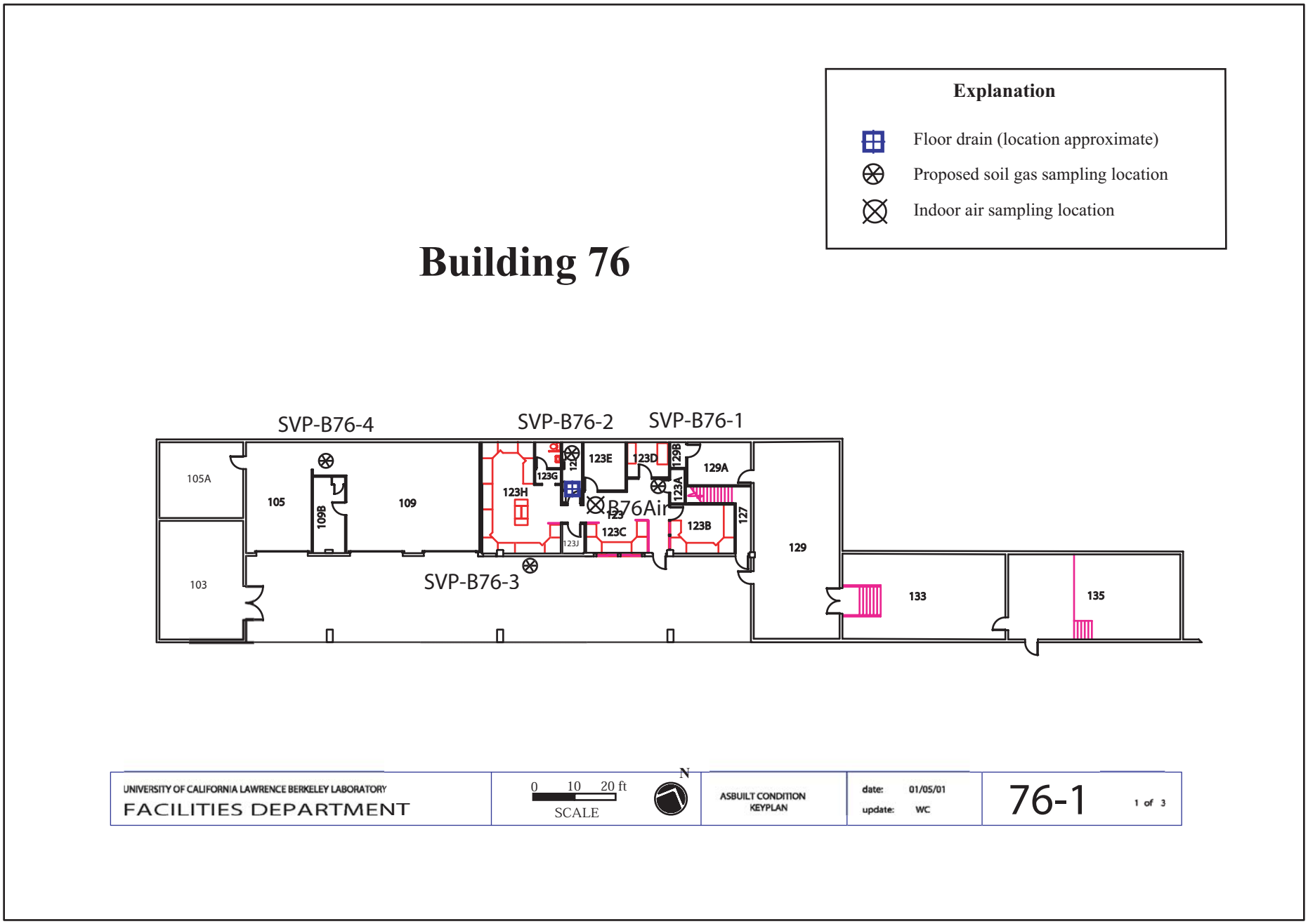

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Figure 21. Locations of Soil Gas Sampling Points and Indoor Air Sampling Location inside Building 76.